Spillway – Alternatives 1 to 3

The drainage basin above the reservoir site is approximately 50 square miles. Preliminary hydrology analysis was performed as part of the 2014 Grand River Consulting report to estimate the inflow design flood (IDF). Based on this analysis, the IDF was estimated to be about 43,000 cfs. Simplified reservoir routing analyses was performed, and a 400-foot long spillway was identified to be required to route the IDF with 14 feet of routing head.

An excavated channel through the right abutment would be a practical and economical spillway configuration. Overtopping spillways are typically not recommended for rockfill dams because of the potential for significant settlement, and the left abutment is too steep to accommodate a spillway. A significant advantage of constructing the spillway through the right abutment is that flows could be discharged to a natural drainageway that eventually discharges to Homestake Creek about half a mile downstream of the dam.

The spillway would consist of a rock cut trapezoidal channel. A concrete control sill would be located at the upstream end of the spillway to hydraulically control flows through the spillway. A cutoff wall would be located at the downstream end of the spillway to prevent headcutting back to the reservoir. A stilling basin would likely not be required. Excavated material would likely be suitable for rockfill or concrete aggregate.

Outlet Works – Alternatives 1 to 3

The outlet works would consist of a low-level, reinforced concrete intake structure near the upstream toe of the dam with a hydraulically actuated slide gates; dual 60-inch diameter steel pipes encased in concrete; and terminal facilities at the downstream end to control flow through the outlet works and dissipate energy for releases to Homestake Creek. The pipe size was selected to provide a hydraulic capacity of 450 cfs, which is the largest recorded native inflow. The pipes would also allow the top 5 feet of the reservoir to be released in less than 5 days, as required by the SEO for a high hazard dam.

If water quality issues are a concern, an intake tower could be constructed instead of a low-level intake structure. An intake tower would be as high as the raised embankment and would accommodate selective withdrawals at various reservoir elevations. A bridge would need to be provided to access the top of the tower. An intake tower would cost significantly more than a low-level intake structure. The cost opinion was developed for a low-level intake structure.

Terminal facilities would be required to safely regulate and control reservoir releases, which could vary from a few cfs to 450 cfs. The terminal facilities would include a buried valve control vault, an above ground control building, and a reinforced concrete energy dissipation structure. It is anticipated that hydraulic controls would include fixed cone valves, isolation valves, and flow meters. The fixed-cone valves would regulate flow through the pipes and provide some energy dissipation. It is anticipated that the control vault would also include a smaller pipeline and valves for low flow releases. The smaller pipeline would bifurcate from one of the 60-inch diameter pipelines. The control building would house electrical equipment, controls from the valves, and instrument readout panels. The pipelines would discharge to an energy dissipation structure, which would consist of a reinforced concrete structure with

impact baffle walls. Riprap channel lining would likely be required along Homestake Creek directly downstream of the energy dissipation structure.

Homestake Road Relocation – Alternatives 1 to 3

Construction of any of the alternatives would inundate large segments of the existing Homestake Road. The following criteria were used to develop potential relocated road alignments:

- Construction would not encroach into the Wilderness Area.
- Design speed limit of 25 mph.
- 20-foot-wide gravel-surfaced roadway.
- 16 percent maximum grade.
- Cut and fill slopes were at 3H:1V for earthen materials or near vertical for rock excavations
- Retaining walls would be required to construct vertical fill slopes and rock bolts or other support may be required to construct vertical cut slopes.

A road realignment was developed along the north side of the valley for Alternatives 1 and 2. The road realignment would extend through relatively steep sections of the valley wall and significant rock excavation would be required. Rock bolts would likely be required to provide stability along the face of the rock. The road realignment would extend very close to the Wilderness Area boundary. Based on discussions with USFS staff, it is understood that this may limit their ability to provide avalanche control operations.

For Alternative 3, the road would need to be relocated along the south side of the valley in the Roadless Area because the steep topography of the north side of the valley at higher elevations. The road could also be relocated along the south side of the valley for Alternatives 1 and 2. The primary advantage of the south side alignment is that the terrain is less steep and less rock excavation would be required. Disadvantages of the south side alignment include:

- Slightly longer alignment.
- Bridges for two crossings of Homestake Creek.
- A bridge crossing the spillway.

Lengths of relocated road for each alternative are shown in **Table 3-3**.

Table 3-3. Road Relocation Lengths – Whitney Creek Reservoir Alternatives

Component	Length (ft)
Alt 1	6,700
Alt 2	8,000
Alt 3	18,800

Alternative 4

The off-channel reservoir site appears suitable to support a dam. Geologic conditions appear similar to Site 2 and, no technical fatal flaws were identified. The geophysical investigations performed for Site 2 did not extend to the Alternative 4 reservoir site, so the initial assessment of the geology is based primarily on published geology maps.

The alternative for a CFRD was developed for the reasons previously described and was sized as a 1,000 ac-ft off-channel reservoir. The chosen site has capacity for up to 3,200 ac-ft of storage if a larger dam is constructed.

A diversion structure and diversion channel would be required to fill the off-channel reservoir from Homestake Creek. The diversion structure would need to be located on Homestake Creek about 6,000 feet upstream of the reservoir to allow the reservoir to be filled completely by gravity. It is understood that the diversion channel would require a capacity of about 300 cfs. The diversion channel would consist of a 6,500-foot long, 10-foot wide trapezoidal channel at a slope of about 0.25 percent to provide a peak capacity of 300 cfs.

The drainage basin above this site is approximately 1.2 square miles. The IDF was estimated to be 4,200 cfs based on simplified hydrologic analyses. Simplified reservoir routing analyses was performed, and a 200-foot long spillway was identified to be required to route the IDF with 4 feet of routing head. An excavated channel through the right abutment would be a practical and economical spillway configuration. The spillway would consist of a rock cut trapezoidal channel with other components similar to the spillway for Alternative 1 to 3.

The outlet works would consist of a low-level, reinforced concrete intake structure near the upstream toe of the dam with a hydraulically actuated slide gates; a 30-inch diameter steel pipe encased in concrete; and a baffled outlet structure at the downstream end. The pipe would provide a peak hydraulic capacity of 100 cfs, which would allow the top 5 feet of the reservoir to be released in less than 5 days. A smaller pipe would have met the SEO drawdown requirement, but would make maintenance activities more difficult. An approximate 300-foot long channel would need to be constructed downstream of the outlet works to convey outlet works releases to Homestake Creek. Similar to Alternatives 1 to 3, a selective withdrawal intake tower with access bridge could be constructed if there are water quality concerns.

Homestake Road would not need to be relocated for this alternative. An access road from Homestake Road would need to be constructed and a bridge over Homestake Creek would be required.

3.2.2.2.2 Conveyance Facilities

Black and Veatch (2012) performed a planning-level evaluation of conveyance facilities to fill Whitney Creek Reservoir by gravity from the Eagle River near Camp Hale using a buried pipeline and to convey water from Whitney Creek Reservoir to Homestake Reservoir by using a buried pipeline and pump stations. Descriptions of project components are not provided in the report, but it is understood that project components were intended to be similar to the 2009 Black and Veatch Report (approximate 30-percent design) for the Eagle Park Reservoir conveyance facilities.

Feasibility-level tunnel alignments were evaluated to fill Whitney Creek Reservoir by gravity from a) Eagle River near Camp Hale, and b) Peterson Creek and Fall Creek. Available published geologic maps and information were reviewed from past geologic work at the Whitney Creek sites to evaluate the feasibility of tunnel construction for these alignments.

Eagle River near Camp Hale to Whitney Creek Reservoir (Pipeline)

Facilities to convey water by a gravity pipeline from the Eagle River near Camp Hale to Whitney Creek Reservoir were evaluated by Black and Veatch in the 2012 report for a peak flow rate of 200 cfs. Flows would be diverted from the Eagle River just downstream of its confluence with Resolution Creek. The location of the diversion structure would need to be coordinated with the restoration work occurring at Camp Hale. The pipeline alignment generally follows the alignment of the existing access road. The pipeline would consist of 6 miles of either 54-inch diameter (pipeline can convey all estimated available water) or 48-inch diameter (some available water spills downstream) steel pipe. It is understood that there are existing unexploded ordnances (UXO) in the Camp Hale area that would need to be identified and properly removed. A general plan of the gravity pipeline is presented on **Figure A-18**. Additional information is presented in the 2012 Black and Veatch report.

Eagle River near Camp Hale to Whitney Creek Reservoir (Tunnel)

A tunnel could be constructed instead of a pipeline to convey water by gravity from the Eagle River near Camp Hale to Whitney Creek Reservoir. A tunnel would be significantly shorter and reduce property and right-of-way issues associated with constructing a pipeline. There were no identified technical fatal flaws that would preclude construction of a tunnel between Camp Hale and Whitney Creek Reservoir. Most of the tunnel would be through hard rock with low weathering and low fracturing, which would be favorable for tunneling. Tunneling would be performed using a tunnel boring machine (TBM). A TBM is a machine that excavates a tunnel with a circular cross section. The leading face of a TBM consists of a rotating cutter head that chips away rock from the face of the tunnel. The TBM uses friction with the walls of the tunnel to generate the required reaction against the tunnel face. Removed material is transported to the rear of the TBM on a conveyor, where it is subsequently removed from the tunnel using additional conveyor systems or muck cars.

The proposed tunnel alignment crosses multiple faults. The faults could potentially create the following difficulties during tunneling:

- Rock within the faults could be highly fractured and weathered, and additional tunnel support may be required.
- Significant groundwater inflow to the tunnel could occur through faults.
- The faults could present non-uniform rock properties at the face of the tunnel, which is not desirable for operation of a TBM.

Rock at the east tunnel portal (near Camp Hale) may be more highly fractured and require extra tunnel support. The tunnel from Camp Hale to Whitney Creek Reservoir would be approximately 3.6 miles. A general plan of the tunnel is presented on **Figure A-19**. Waste rock from tunneling would likely be used in construction of dams.

Fall Creek and Peterson Creek to Whitney Creek Reservoir

It may be desirable to fill the reservoir from Peterson Creek and Fall Creek, which are located to the north of the Whitney Creek site. A diversion structure would be located on Fall Creek and flows would be conveyed to Peterson Creek through a 4,100-foot-long tunnel. A diversion structure would be located

on Peterson Creek downstream of the Fall Creek tunnel outlet and flows would be conveyed through a 4.5-mile-long tunnel to Whitney Creek Reservoir. There were no identified technical fatal flaws that would preclude construction of these tunnels. Tunnel conditions would be similar to those described for the tunnel from Camp Hale to Whitney Creek Reservoir. A landslide is mapped upstream of the Peterson Creek diversion structure. Similar geologic conditions exist in this area, and this area could be susceptible to additional landslides. A general plan of the conveyance facilities is presented on **Figure A-20**.

Whitney Creek Reservoir to Homestake Reservoir

Facilities to convey water from the Whitney Creek Reservoir to Homestake Reservoir were evaluated by Black and Veatch in the 2012 report for peak flow rate of 200 cfs. The pipeline alignment would generally follow the alignment of Homestake Road. The 200 cfs system would include 7 miles of 48-inch or 54-inch diameter steel pipe; two 17,000 Hp pump stations; an electrical substation; and electrical distribution cables. A general plan of the pipeline and pump stations is presented on **Figure A-18**.

3.2.3 Bolts Lake

3.2.3.1 Existing Facilities

Bolts Lake was originally constructed in the early 1880's (Applegate, 2010) for water storage and recreation purposes. The reservoir was historically filled through a diversion ditch from Cross Creek. The dam was breached in the 1990's by order of the SEO because of stability and seepage concerns. The breach lowered the reservoir to an elevation that resulted in the dam being classified as "non-jurisdictional".

Mining and subsequent remediation actions have historically occurred in the areas immediately surrounding the reservoir. The reclaimed mining areas are part of the Eagle Mine Superfund Site. Relocation of mine wastes was completed in 1994 and the main tailings piles were capped in 1997. The "Consolidated Tailings Pile" is located to the north of the reservoir and the "Old Tailings Pile" is located to the southwest of the reservoir (Applegate 2010). A water treatment plant was constructed in 1990 to treat mine seepage, groundwater from the tailings piles, and stormwater runoff from the tailings piles. A mine water transport pipe extends along the north side of Bolts Lake to the water treatment plant.

3.2.3.2 Evaluations

Work at the Bolts Lake site would consist of the following components:

- Removing the existing dam and stockpiling materials for reuse.
- Excavating the existing reservoir to create more storage and provide construction materials for a new dam.
- Constructing two new dams: a main dam along the northeast (downstream) portion of the reservoir and a saddle dam along the southwest (upstream) side of the dam.
- Constructing conveyance facilities to fill the reservoir from one of the following diversion locations:
    - Eagle River at Diversion Structure No. 2

- Eagle River at Diversion Structure No. 3

A general plan of facilities for the Bolts Lake site is presented on **Figure A-21**.

Cost opinions associated with the following facilities are presented in **Section 3.3**.

3.2.3.2.1 Dam and Reservoir

Based on review of engineering evaluations by other consultants and published geologic mapping, it is understood that the key issues impacting construction of a dam and reservoir at the Bolts Lake site include:

- Existing groundwater levels are relatively high (i.e. about 10 to 15 feet above the proposed reservoir floor).
- Superfund sites are located around the reservoir. The reservoir would need to be hydraulically isolated from the surrounding environment and not change the existing groundwater regime. One option for hydraulically isolating the reservoir would be to construct a reservoir liner. However, this may alter existing groundwater regime because the liner would be constructed below existing groundwater levels.
- Surficial soils consist of glacial deposits ranging from 30 to over 100 feet thick over Leadville Dolomite bedrock. It would be costly to construct seepage management facilities that extend to bedrock, and a reservoir liner would likely be a more cost effective concept for providing seepage control.
- The dam would be located upstream of the City of Minturn and would likely be high hazard even though the storage volume is much lower compared to the other ERMOU project sites.

Applegate Group (2010) evaluated two 1,200 ac-ft reservoir configurations at Bolts Lake. The first alternative was selected to not disturb the existing mine water transport pipeline. The second alternative requires relocation of the pipeline but also allows for a dam that is about 6-feet less in height. Concepts for the dam and ancillary facilities developed by Applegate Group (2010) include a zoned rockfill main dam and saddle dam constructed using on-site materials, an outlet works with multilevel outlet tower and access bridge, and a synthetic liner. The reservoir would have a very small drainage basin (about 0.1 square miles) and the reservoir could store the IDF. A spillway would be located on the multilevel tower and flows would discharge through the outlet works pipe.

8140 Partners, LLC. (2012) subsequently performed a more detailed evaluation of the reservoir liner. Their preferred concept for the liner includes a 3-foot layer of protective soil over a geosynthetic clay liner over a geo-net drainage layer. An alternate concept would be to construct a traditional clay liner, but there may not be sufficient clay materials nearby. Based on review of the drawings, it is the opinion of the ERMOU Technical Advisors that the design concept does not satisfy the design intent. The liner drain would be installed below the natural groundwater table, which would collect groundwater and change seepage patterns. This could be mitigated by constructing a second liner below the drain, but this would cause uplift concerns when the reservoir is empty. Costs for this concept were developed in accordance with the scope of work. However, it is probable that the concept as currently configured

would not be acceptable and that modification to the concept will increase the cost. The liner concept needs to be further evaluated in future stages of project development.

3.2.3.2.2 Conveyance Facilities

Applegate Group (2010) evaluated conveyance facilities to fill Bolts Lake from the Eagle River for a peak flow of 50 cfs at two locations: Diversion No. 2 located about 3,600 feet upstream of the reservoir and Diversion No. 3 located adjacent to the reservoir. Both alternatives would allow the bottom portion of the reservoir to be filled by gravity while the upper portion of the reservoir would be filled by pumping. Diversion Structure No. 2 would require an additional 3,300 feet of pipeline compared to Diversion Structure No. 3 but would also allow a larger portion of the reservoir to be filled by gravity because its intake is further upstream. An elevation-capacity curve for the reservoir was not provided; therefore, evaluation of the percent of the reservoir that could be filled by gravity for both alternatives was not completed.

Conveyance facilities for Diversion Structure No. 2 would include a diversion structure on the Eagle River; 4,000 linear feet of 48-inch diameter steel pipe; a 320 Hp pump station located near the dam, and electrical transformer.

Conveyance facilities for Diversion Structure No. 3 would include a diversion structure on the Eagle River; 680 linear feet of 30-inch diameter steel pipe; a 410 Hp pump station located near the dam, and electrical transformer. The pipeline from Diversion Structure No. 3 would also need to cross beneath Highway 24.

The reservoir would be drained to the Eagle River through the outlet works for both alternatives. If Diversion Structure No. 3 is selected, it may be possible to combine the outlet works and conveyance facilities.

3.2.4 Wolcott Reservoir

3.2.4.1 Existing Facilities

There are no hydraulic facilities located at the Wolcott Reservoir site. State Highway 131 extends along the east edge of the valley.

3.2.4.2 Evaluations

Work at the Wolcott Reservoir site would consist of the following components:

- Constructing a new dam on Alkali Creek.
- Constructing conveyance facilities to fill the reservoir from one of the following diversion locations:
    - Eagle River near Dowds Junction
    - Eagle River near confluence with Alkali Creek
- Relocating a portion of State Highway 131 around the reservoir.

A general plan of facilities for the Wolcott Reservoir site is presented on **Figure A-22**.

Cost opinions associated with the following facilities are presented in **Section 3.3**.

3.2.4.2.1 Dam and Reservoir

GEI Consultants evaluated constructing a dam and reservoir on Alkali Creek approximately one mile north of the town of Wolcott as part of the 2014 Grand River Consulting Report. The dam would be 210 feet high with a storage capacity of 45,000 ac-ft. An embankment type and layout were not presented in the report. The outlet works would consist of a multilevel intake tower with access bridge from the dam crest and dual 87-inch diameter outlet pipes. The drainage basin for the reservoir is approximately 45 square miles. The IDF would be stored in the reservoir and released through a small service spillway in the outlet works intake tower. The reservoir would inundate an approximate 5-mile section of State Highway 131. The road would be relocated along the east side of the reservoir.

3.2.4.2.2 Conveyance Facilities

Eagle River near Dowds Junction to Wolcott Reservoir

Western Engineers, Inc. (1987) evaluated conveyance facilities to convey water from the Eagle River near Dowds Junction to Wolcott Reservoir. The reservoir could be completely filled by gravity flow through the pipeline with a peak flow of 175 cfs. The pipeline would also be designed for bi-directional flow so that water from the reservoir could be conveyed to the Eagle River near Dowds Junction at 20 cfs by pumping. The pipeline alignment generally follows the alignment of U.S. Highway 6. Significant development has occurred along the corridor of the highway since the alignment was developed in 1987. Significant changes to the alignment may be required if this alternative is selected for further evaluation. The conveyance system would include a diversion structure; 15.7 miles of 60-inch diameter steel pipe; a 1,400 Hp pump station; and an electrical transformer. A plan and hydraulic schematic profile is presented on **Figure A-23**.

Eagle River near Alkali Creek to Wolcott Reservoir

Facilities to convey water from the Eagle River near its confluence with Alkali Creek were evaluated for a peak flow rate of 150 cfs. The pipeline alignment would generally parallel Alkali Creek. The 150 cfs system would include a diversion structure; 0.9 miles of 60-inch diameter steel pipe; a 10,000 Hp pump station; and an electrical transformer. A plan and hydraulic schematic profile is presented on **Figure A-24**.

3.3 Results Summary – Cost Opinions

Cost opinions were developed for the various facility configurations associated with Eagle Park Reservoir, Whitney Creek Reservoir, Bolts Lake, and Wolcott Reservoir using the approach presented in **Section 3.1**. Cost opinions for each facility are presented in **Table 3-4**.

Table 3-4. Opinion of Probable Construction Costs – ERMOU Project Alternatives

Component	Conveyance	Capacity	Average Pump Rate (ac-ft/yr)	Capital Cost ($M)	Fixed O&M Cost[4] ($M)	Variable O&M Cost[4] ($M)	Total Cost[5] ($M)
Eagle Park Reservoir							
Dam[1]	-	7,950 ac-ft	-	$ 68.4	$ 2.4	$ -	$ 70.8
Dam[2]	-	7,950 ac-ft	-	$ 37.8	$ 1.3	$ -	$ 39.1
Pipe/Pump	Eagle R blw Resolution Ck	40 cfs	8,000	$ 88.2	$ 12.0	$ 41.8	$ 142.0
Pipe/Pump	Eagle R blw Resolution Ck	40 cfs	5,000	$ 88.2	$ 12.0	$ 35.5	$ 135.7
Pipe/Pump	Eagle R blw Resolution Ck	150 cfs	8,000	$ 177.4	$ 28.1	$ 112.5	$ 318.0
Pipe/Pump	Eagle R blw Resolution Ck	150 cfs	5,000	$ 177.4	$ 28.1	$ 106.0	$ 311.5
Pipe/Pump	E Fk Eagle R blw Jones G	100 cfs	8,000	$ 93.0	$ 15.1	$ 68.6	$ 176.7
Pipe/Pump	E Fk Eagle R blw Jones G	100 cfs	5,000	$ 93.0	$ 15.1	$ 63.1	$ 171.2
Pipe/Pump	E Fork Eagle R (exist PS)	50 cfs	1,500	$ 30.1	$ 5.2	$ 8.5	$ 43.8
Pipe/Pump	Eagle Park Res to Chalk Ck	50 cfs	7,000	$ 37.0	$ 5.1	$ 21.7	$ 63.8
Pipe/Pump	Eagle Park Res to Chalk Ck	50 cfs	3,500	$ 37.0	$ 5.1	$ 18.2	$ 60.3
Whitney Creek Reservoir							
Dam-Alt 1	-	4,600 ac-ft	-	$ 67.9	$ 2.4	$ -	$ 70.3
Dam-Alt 2	-	6,850 ac-ft	-	$ 82.0	$ 2.9	$ -	$ 84.9
Dam-Alt 3	-	20,000 ac-ft	-	$ 106.8	$ 3.8	$ -	$ 110.6
Dam-Alt 4	-	1,000 ac-ft	-	$ 45.9	$ 1.6	$ -	$ 47.5
Pipe[3]	Eagle R blw Resolution Ck	200 cfs	-	$ 44.7	$ 2.7	$ -	$ 47.4
Tunnel	Eagle R blw Resolution Ck	200 cfs	-	$ 92.2	$ 2.8	$ -	$ 95.0
Tunnel	Fall/Peterson Creeks	200 cfs	-	$ 135.7	$ 4.8	$ -	$ 140.5
Pipe/Pump[3]	Whitney Ck Res to HS Res	200 cfs	20,000	$ 203.5	$ 21.7	$ 113.8	$ 339.0
Pipe/Pump[3]	Whitney Ck Res to HS Res	200 cfs	13,000	$ 203.5	$ 21.7	$ 103.7	$ 328.9
Bolts Lake							
Dam/Liner	-	1,200 ac-ft	-	$ 28.9	$ 1.0	$ -	$ 29.9
Pipe/Pump	Eagle R (Div Str No. 2)	50 cfs	600	$ 21.5	$ 5.0	$ 0.8	$ 27.3
Pipe/Pump	Eagle R (Div Str No. 3)	50 cfs	600	$ 17.7	$ 4.9	$ 1.1	$ 23.7
Wolcott Reservoir							
Dam	-	45,000 ac-ft	-	$ 216.0	$ 6.7	$ -	$ 222.7
Pipe/Pump	Eagle R nr Alkali Ck	150 cfs	13,000	$ 38.2	$ 9.0	$ 25.3	$ 72.5
Pipe/Pump	Eagle R nr Dowds Jct	175 cfs	13,000	$ 130.7	$ 8.4	$ 11.3	$ 150.4

1. Foundation seepage improvements below existing and new dam
2. Foundation seepage improvements below new dam only
3. Based on 54-inch diameter pipe
4. O&M costs represent present day costs based on 50-year life-span, 6.3 % interest rate, 3.8% inflation rate
5. Costs for property acquisition and easements are not included; costs for conveyance facilities are based on unit costs developed by Black and Veatch (2009), escalated to 2016 dollars

Section 4 Evaluations – Water Supply and Project Yield

4.1 Evaluation Approach

Water supply and project yield evaluations were completed by WWG with technical input and peer review by H&W, LRE, and WWW. Work was coordinated with other technical disciplines to provide a basis for and review of water yield evaluations.

Numerous water supply and project yield evaluations have been performed by various consultants for ERMOU project sites over the last 30 years. Some evaluations were performed for the collective ERMOU Partners, while others were performed for individual Partners or other entities. These evaluations varied from project to project with a broad range of level of detail. The ERMOU Partners directed the ERMOU Technical Advisors to maximize use of these existing water yield evaluations for this Phase 2 Study, in conjunction with performing new water yield evaluations for Phase 2 project alternatives. **Section 7** presents a summary of previous studies reviewed to support water supply and project yield evaluations.

Water supply and project yield evaluations were completed for the three Tier 1 project alternatives (Eagle Park Reservoir, Whitney Creek Reservoir, and Bolts Lake) and for one Tier 2 project alternative (Wolcott Reservoir). Evaluations included investigations into the amount of water supply and project yield that could be available for each alternative (project scenarios) and for combinations of scenarios (project portfolios). Primary objectives of these evaluations were to estimate firm dry year yield for West Slope supply and average yield for East Slope supply through operation of the four project alternatives and to develop preliminary capacity needs for project conveyance and storage facilities. As defined in the ERMOU, firm dry year yield is the amount of water that is available in the 25 percent driest of years during the Study period; average yield is the amount of water available for diversion on a 25-year rolling average.

Water supply and project yield were evaluated with a daily simulation model of the Eagle River watershed. The model simulates project water conveyance and storage for the historical 1946 through 2014 period. The model can simulate varied configurations (current and potential) of Eagle Park Reservoir, Whitney Creek Reservoir, Bolts Lake, and Wolcott Reservoir with consideration for the following key operational parameters in the simulation model.

- Colorado River main stem water rights
- Eagle River and tributary instream flow water rights and bypass flows
- Reservoir capacity and evaporation
- Pump and pipeline capacity

The operational simulation used in this Study is based upon the historical hydrologic conditions that occurred from 1946 through 2014. Within this Study period, simulation results reflect that the critical limiting supply periods are typically 1954–1956 and 2001–2004. Actual water supply will vary in response to climatic conditions that occur in the future.

Study results are influenced by operating assumptions used in the model. Key data and model operating criteria are discussed below.

- Hydrologic data used for this Study includes synthesized native flow data developed for 1) gravity inflow to Eagle Park Reservoir, 2) Eagle River at Red Cliff gage, 3) East Fork Eagle River Near Climax Gage, and 4) East Fork Pumping Plant. **Appendix B** includes a technical memorandum on corresponding data development.
- West Slope demand patterns and reservoir release patterns developed as part of this Study are based on year type (wet, dry or average) and are primarily concentrated in the winter months when water is needed for snowmaking and to increase low flows. **Appendix B** includes a technical memorandum on corresponding data development.
- ERMOU project alternatives are operated with 1952 water right priorities under the assumption that 1952 Homestake conditional rights will be used for the alternatives.
- Direct flow diversions are subject to frequent curtailment by senior downstream water rights including the Cameo and Shoshone calls.
- ERMOU project alternatives are operated as being junior to instream flow water rights decreed to the Colorado Water Conservation Board. Reservoir diversions occur only when stream flow exceeds appropriate instream flow values.
- Reservoir releases are made from single-account pools although the releases are made for different purposes and for different cooperating parties. Under this simplifying assumption, reservoirs are operated very efficiently, and water may be periodically borrowed from one party's portion of the reservoir to satisfy the demands of another party.
- Analysis was performed under the assumption that East Slope yields are unconstrained by East Slope infrastructure and operations and there is sufficient capacity in the East Slope delivery and storage systems to receive and fully utilize all water delivered by the ERMOU Project.
- East Slope average yield is always pumped from storage and varies based on a threshold reservoir capacity that must be met for East Slope pumping to occur.
- Project yields, conveyance, and storage capacities were estimated through an iterative simulation process of varying and balancing East Slope and West Slope ERMOU yield objectives, water and storage availability, and engineering judgement and costs. These iterative evaluations were completed first for each individual ERMOU facility (project scenarios) and then for combinations of selected ERMOU facilities (project portfolios).

4.2 Project Evaluations

4.2.1 Eagle Park Reservoir

Section 0 describes engineering evaluations for conveyance and storage facilities associated with the Eagle Park Reservoir concepts. Operations and water yield associated with those concepts was evaluated with the daily simulation model of the Eagle River watershed, described in **Section 4.1**. Five scenarios were evaluated as follows to understand how ERMOU objectives may be met with various configurations of Eagle Park Reservoir operations.

- **Scenario EP1 –** An enlarged Eagle Park Reservoir (**7,950 ac-ft**) would receive water from the existing pump station and pipeline (**6 cfs**) located on the East Fork Eagle River, and the system would be operated exclusively for West Slope purposes.

- **Scenario EP2 –** Same configuration as Scenario **EP1**, except the existing pump station and pipeline would be replaced with an enlarged conveyance system (**25-50 cfs**). The system would be operated exclusively for West Slope purposes.

- **Scenario EP3 –** An enlarged Eagle Park Reservoir (**7,950 ac-**ft) would receive water from a new pump station and pipeline (**40 cfs**) from the Eagle River below Resolution Creek, and the system would be operated exclusively for West Slope purposes.

- **Scenario EP4 –** An enlarged Eagle Park Reservoir (**7,950 ac-ft**) would receive water from a new pump station and pipeline (**100 cfs**) from the East Fork Eagle River below Jones Gulch, and water could be transferred from Eagle Park Reservoir to Chalk Creek in the Arkansas River basin with a new pump station and pipeline (**50 cfs**). The system would be operated for both West Slope and East Slope purposes.

- **Scenario EP5 –** An enlarged Eagle Park Reservoir (**7,950 ac-ft**) would receive water from a new pump station and pipeline (**150 cfs**) from the Eagle River below Resolution Creek, and water could be transferred from Eagle Park Reservoir to Chalk Creek in the Arkansas River basin with a new pump station and pipeline (**50 cfs**). The system would be operated for both West Slope and East Slope purposes.

4.2.2 Whitney Creek Reservoir

Section 0 describes engineering evaluations for conveyance and storage facilities associated with the Whitney Creek Reservoir concepts. Operations and water yield associated with those concepts were evaluated with the daily simulation model of the Eagle River watershed, described in **Section 4.1**. Six scenarios were evaluated as follows to understand how ERMOU objectives may be met with various configurations of Whitney Creek Reservoir operations.

- **Scenario WC1 –** This scenario represents a reservoir size where encroachment of the Holy Cross Wilderness area would not occur from either construction activities or reservoir inundation. A new Whitney Creek Reservoir (**4,600 ac-ft**) would receive water from Homestake Creek and from the Eagle River below Resolution Creek through a new tunnel (**200 cfs**), and water would be transferred from Whitney Creek Reservoir to Homestake Reservoir with a new pump station and pipeline (**200 cfs**). The system could be operated for both West Slope and East Slope purposes.

- **Scenario WC2 –** Same configuration as Scenario **WC1**, except with a reservoir size (**6,850 ac-ft**) where encroachment of the Holy Cross Wilderness area would not occur from construction activities, but may occur from reservoir inundation. The system could be operated for both West Slope and East Slope purposes.

- **Scenario WC3 –** Same configuration as Scenario **WC1**, except with a relatively large reservoir size (**20,000 ac-ft**) with associated construction activities and reservoir inundation that would not be constrained by the existing Holy Cross Wilderness area boundary (i.e. that a Wilderness boundary adjustment could be secured). The system could be operated for both West Slope and East Slope purposes.

- **Scenario WC4 –** Same configuration as Scenario **WC1** except with a relatively small off-channel reservoir with a size (**1,000 ac-ft**) and location intended to reduce environmental impact and not encroach on the Holy Cross Wilderness area. The system would be operated as a forebay exclusively for East Slope purposes to transfer water to Homestake Reservoir; water could be released from Homestake Reservoir for West Slope purposes.

- **Scenario WC5 –** Same configuration as Scenario **WC3** with added water supply through a new tunnel (**200 cfs**) from Fall and Peterson Creeks. The system could be operated for both West Slope and East Slope purposes.

- **Scenario WC6 –** Same configuration as Scenario **WC4** with added water supply through a new tunnel (**200 cfs**) from Fall and Peterson Creeks. The system would be operated as a forebay exclusively for East Slope purposes to transfer water to Homestake Reservoir; water could be released from Homestake Reservoir for West Slope purposes.

- **Scenario WC7 –** Same configuration as Scenario **WC1** with added water supply through a new tunnel (**200 cfs**) from Fall and Peterson Creeks. The system could be operated for both West Slope and East Slope purposes.

- **Scenario WC8 –** Same configuration as Scenario **WC2** with added water supply through a new tunnel (**200 cfs**) from Fall and Peterson Creeks. The system could be operated for both West Slope and East Slope purposes.

4.2.3 Bolts Lake

Section 0 describes engineering evaluations for conveyance and storage facilities associated with the Bolts Lake concept. Operations and water yield associated with that concept were evaluated with the daily simulation model of the Eagle River watershed, described in **Section 4.1**. One scenario was evaluated as follows to understand how ERMOU objectives may be met with Bolts Lake operations.

- **Scenario BL1 –** An upgraded Bolts Lake (**1,200 ac-ft**) would receive water from a new pump station and pipeline (**50 cfs**) from the Eagle River, and the system would be operated exclusively for West Slope purposes.

4.2.4 Wolcott Reservoir

Section 0 describes engineering evaluations for conveyance and storage facilities associated with the Wolcott Reservoir concept. Operations and water yield associated with that concept were evaluated with the daily simulation model of the Eagle River watershed, described in **Section 4.1**. One scenario was evaluated as follows to understand how ERMOU objectives may be met with Wolcott Reservoir operations.

- **Scenario WR1 –** A new Wolcott Reservoir (**45,000 ac-ft**) would receive water from a new pump station and pipeline (**175 cfs**) from the Eagle River at Dowds Junction, and the system would be operated exclusively for West Slope purposes.

4.2.5 Scenario Summary

Table 4-1 provides a summary of scenarios presented above and corresponding facility configurations of Eagle Park Reservoir, Whitney Creek Reservoir, Bolts Lake, and Wolcott Reservoir. Simulated cost/yield estimates for these scenarios are presented below in **Section 4.3**.

Table 4-1. Yield Scenarios – ERMOU Project Alternatives

Scenario	Water Source	Capacity (cfs)		New Storage (ac-ft)[1]
		From Source	To E. Slope	
Eagle Park Reservoir				
EP1	East Fork Eagle River	6	-	4,650
EP2	East Fork Eagle River	50	-	4,650
EP3	Eagle River below Resolution Creek	40	-	4,650
EP4	East Fork Eagle River below Jones Gulch	100	50	4,650
EP5	Eagle River below Resolution Creek	150	50	4,650
Whitney Creek Reservoir				
WC1	Eagle River below Resolution Creek	200	200	4,600
WC2		200	200	6,850
WC3		200	200	20,000
WC4		200	200	1,000
WC5	Eagle River below Resolution Creek and Fall/Peterson Creeks	200	200	20,000
WC6		200	200	1,000
WC7		200	200	4,600
WC8		200	200	6,850
Bolts Lake				
BL1	Eagle River at Bolts Lake	50	-	1,200
Wolcott Reservoir				
WR1	Eagle River at Dowds Junction	175	-	45,000

[1] Eagle Park Reservoir storage does not include existing 3,300 ac-ft storage.

4.2.6 Tier 2 Project Summaries

As noted in **Section 2.2**, Piney River Reservoir, Iron Mountain Reservoir, and Eagle-Arkansas Ditch are considered potential ERMOU facilities that require compilation of preliminary information to assess their potential to contribute to ERMOU water yield objectives (Tier 2). Below is a summary of existing information associated with Piney River Reservoir, Iron Mountain Reservoir, and Eagle-Arkansas Ditch.

Piney River Reservoir

In the early 1970s, Denver Water initiated detailed engineering investigations of the Eagle-Piney Eagle-Colorado project as a potential extension of its Roberts Tunnel Collection System. This proposed project included Piney Reservoir with a storage capacity of 40,000 acre-feet located on the upper Piney River and a gravity flow collection system to divert water from tributaries of the Piney River (Meadow Creek, East Meadow Creek, Moniger Creek, Freeman Creek, and Dickson Creek) to the reservoir. The proposed project also included a system of tunnels and diversion structures to convey water from Piney Reservoir and tributaries of Gore Creek, including Red Sandstone Creek, to Dillon Reservoir (Parson Brinkerhoff et al., 1974).

A substantial portion of the upper Piney River Basin, including much of the Piney Reservoir site, was included in the Eagles Nest Wilderness Area, which was designated by the U.S. Congress in 1976. Denver Water conducted an evaluation of alternative configurations of the Eagle-Piney/Eagle Colorado Project including options that would avoid the need for any wilderness boundary changes or a Presidential exemption. This study found that Piney Reservoir could be downsized to approximately 5,000 acre-feet with a collection system consisting of pump diversions from Moniger, Dickson, and Freeman Creeks that would avoid infringement upon the wilderness area (Brown and Caldwell, 2000). Water collected through this concept would be delivered from Piney River Reservoir to Red Sandstone Creek, a tributary of Gore Creek, through a 66-inch diameter tunnel.

The Brown and Caldwell study (2000) included evaluations of potential biological/ecological environmental impacts, social/cultural impacts, and an institutional analysis. In summary, these investigations found that construction of the relocated Piney Reservoir outside of the wilderness area would be very difficult due to numerous institutional, political and legal issues including impacts to wetlands and aquatic habitat, wildlife habitat, and recreation. The project would be located on Forest Service land and would cause flow depletions to the Piney River below the reservoir where it flows through the Eagles Nest Wilderness Area. The Forest Service may impose bypass flow requirement or claim wilderness reserved water rights which could reduce the yield of the reservoir.

The USGS operated stream gages on the Piney River near the proposed reservoir site and on Dickson and Freeman Creeks. CWCB holds instream flow water rights on those streams. **Appendix B** includes a technical memorandum on the Piney River Reservoir project including a summary of combined streamflow volumes that exceed instream flow water rights. The combined stream flows exceeding the instream flow rights on each stream averaged 16,732 acre-feet annually. During snowmelt runoff, May through July, the stream flows exceeding the instream flows averaged 15,484 acre-feet annually and ranged from 4,701 acre-feet in 2002 to 26,526 acre-feet in 1984. These stream flows exclude Moniger Creek, which was not gaged.

Brown and Caldwell (2000) estimated the firm annual yield of the reconfigured project to be approximately 4,000 ac-ft per year with an initial capital cost of $91,000,000. The yield to storage ratio was estimated to be 4,000 acre-feet of annual yield to 5,041 acre-feet of storage. Further evaluation would be required to update costs to current levels and to update yield evaluations to represent current conditions.

Iron Mountain Reservoir

Iron Mountain Reservoir is the principal feature of the Red Cliff Project initially conceived in the 1950s as an on-channel reservoir on Homestake Creek with a decreed capacity of over 68,000 ac-ft. Homestake Creek yield to the reservoir was to be supplemented by supply from the Eagle River (via the Pando Feeder Canal) and Fall and Peterson Creeks (via pipelines), for a combined annual project yield of 26,000 ac-ft. The project was also conceived to include hydropower infrastructure and operations (Gilman Power Conduit). Water rights associated with those operations have a 1956 appropriation date. Subsequent water rights acquisitions include diversions from Cross Creek (1976 appropriation) and a second fill right for the reservoir (1981 appropriation) to increase reservoir yield. Recent diligence activities abandoned a portion of the Cross Creek diversion rights and a portion of the first and second fill storage rights.

Project development activities have been conducted since project water rights were first obtained:

- 1960s and 1970s geotechnical investigations of the Iron Mountain dam site by Woodward Clyde
- 1970s investigations by David E. Fleming Co. on the Red Cliff/Homestake Extension Joint Project
- 1980s investigations by Western Engineers on preliminary designs of conveyance structures
- 1990 Enartech pre-feasibility assessment of the Iron Mountain Reservoir Joint Use Project
- 1995 Ueblacker reconnaissance level geologic evaluation of dam sites

The 1995 Ueblacker study concluded that the Iron Mountain dam site appears to be geologically acceptable and that construction costs of a roller compacted concrete dam are estimated to range from $36 million to $40 million. The 1990 Enartech study included an evaluation of annual firm yield and capital costs for the project to be divided between West Slope and East Slope uses. Water would be conveyed to the reservoir by pipeline from the Eagle River and by a four-mile gravity tunnel from Peterson, Fall, and Cross Creeks. Water would be pumped through a pipeline from Iron Mountain Reservoir to the existing Fancy-French Conduit and then conveyed by gravity through the Homestake Tunnel to the Arkansas River basin for East Slope use. A hydroelectric generating station would be constructed and operated at Iron Mountain Reservoir.

The 1990 Enartech report concluded that the project could provide approximately 62,300 ac-ft of annual firm yield (20,700 ac-ft allocated to the Colorado River Water Conservation District for West Slope use and 41,600 ac-ft allocated to the Homestake Partners for East Slope use). Capital costs were estimated to be approximately $196.3 million ($140.6 million for the Homestake Partners and $55.7 million for the Colorado River Water Conservation District). Further evaluation would be required to update costs to current levels and to update yield evaluations to represent current conditions.

Eagle-Arkansas Ditch

The Eagle-Arkansas Ditch is a concept that would divert water from four tributaries in the East Fork Eagle River drainage basin (Cataract Creek, Sheep Gulch, Jones Gulch, and East Fork Eagle River) and from three tributaries in the South Fork Eagle River drainage basin (Fiddler Creek, Taylor Creek, and Piney Creek) and convey the water by gravity over Tennessee Pass to the Arkansas River basin for use by East Slope ERMOU Partners. Conveyance facilities would include a new common gravity pipeline

connecting the seven tributaries to an existing abandoned railroad tunnel under Tennessee Pass. The common pipeline would parallel existing access roads along the East Fork Eagle River and south of Camp Hale and then along Highway 24 to the Tennessee Pass tunnel. Following is a list of key information referenced from a 2012 Black and Veatch report and a 2013 Grand River report.

- The project was decreed through CA1193 as part of the larger Homestake Project with a 1952 appropriation date and water right amounts ranging from 20 cfs for the smaller tributaries to 230 cfs for the East Fork Eagle River.
- Available physical water supply for the project is reduced by diversions to Climax and to the Columbine and Ewing ditches, which collect water from approximately 35 percent of the watershed area upstream of the Eagle-Arkansas Ditch.
- The project may provide approximately 400 ac-ft of annual firm yield and 3,800 ac-ft of annual average yield (ranging from 50 ac-ft in dry years to over 11,400 ac-ft in wet years).
- Capital costs were estimated to be $68 million.
- The project poses significant maintenance challenges to make each diversion location operable each spring.

Further evaluation would be required to update costs to current levels and to update model simulations to represent current water rights. Following are next steps recommended in the Black and Veatch report.

- Obtain additional years of stream gage data for the Eagle-Arkansas Ditch and update hydrology as needed
- Work with the Homestake Partners to determine actual yield that can be realized given East Slope operations.
- Through coordination with Union Pacific Railroad, determine applicable requirements to use the abandoned railroad tunnel to convey water.

4.3 Results Summary – Cost/Yield Estimates

4.3.1 Scenario Cost/Yield Estimates

Yields were estimated for various facility configurations (scenarios) associated with Eagle Park Reservoir, Whitney Creek Reservoir, Bolts Lake, and Wolcott Reservoir using the approach presented in **Section 4.1**, and the yields were combined with cost opinions presented in **Section 3.3**. Resulting cost/yield estimates for each scenario are presented in **Table 4-2**. Specific scenarios associated with Eagle Park Reservoir (EP4 and EP5) and Whitney Creek Reservoir (WC1, WC2, WC3, and WC5) each include five cost/yield estimates to represent a range of yield ratios balanced between West Slope and East Slope uses.

Table 4-2. Cost/Yield Estimates – ERMOU Scenarios

Scenario	Water Source	Capacity (cfs)		Capital Cost[1] ($M)	New Storage (ac-ft)	New Annual Yield[2] (ac-ft)			Cost/Yield ($/ac-ft)
		From Source	To E. Slope			W.Slope Firm	E.Slope Average	Total	
Eagle Park Reservoir									
EP1	E Fk Eagle R	6	0	$ 70.8	4,650	1,500	0	1,500	$ 47,200
EP2		50	0	$ 114.6	4,650	1,750	0	1,750	$ 65,486
EP3	Eagle R blw Res Ck	40	0	$ 212.8	4,650	3,000	0	3,000	$ 70,933
EP4	E Fk Eagle R blw Jones G	100	50	$ 311.3	4,650	0	4,200	4,200	$ 74,119
						250	3,700	3,950	$ 78,810
						1,100	3,200	4,300	$ 72,395
						1,750	2,800	4,550	$ 68,418
						2,250	1,800	4,050	$ 76,864
EP5	Eagle R blw Resolution Ck	150	50	$ 452.6	4,650	0	10,700	10,700	$ 42,299
						500	9,400	9,900	$ 45,717
						1,500	7,900	9,400	$ 48,149
						2,250	6,400	8,650	$ 52,324
						3,000	4,500	7,500	$ 60,347
Whitney Creek Reservoir									
WC1	Eagle R blw Resolution Ck	200	200	$ 504.3	4,600	500	16,900	17,400	$ 28,983
						1,250	16,200	17,450	$ 28,900
						1,750	15,500	17,250	$ 29,235
						2,250	14,700	16,950	$ 29,752
						2,500	12,700	15,200	$ 33,178
WC2		200	200	$ 518.9	6,850	750	16,800	17,550	$ 29,567
						1,750	16,100	17,850	$ 29,070
						2,500	15,300	17,800	$ 29,152
						3,000	14,500	17,500	$ 29,651
						3,750	12,300	16,050	$ 32,330
WC3		200	200	$ 544.6	20,000	2,250	16,100	18,350	$ 29,678
						4,250	14,800	19,050	$ 28,588
						6,500	13,300	19,800	$ 27,505
						8,750	11,700	20,450	$ 26,631
						10,000	9,500	19,500	$ 27,928
WC4		200	200	$ 481.5	1,000	-	15,600	15,600	$ 30,865
WC5	Eagle R blw Resolution Ck + Fall/Peterson Creeks	200	200	$ 685.1	20,000	2,750	23,100	25,850	$ 26,503
						5,000	21,600	26,600	$ 25,756
						7,000	19,700	26,700	$ 25,659
						9,000	16,900	25,900	$ 26,452
						11,000	13,500	24,500	$ 27,963
WC6		200	200	$ 622.0	1,000	-	19,900	19,900	$ 31,256
WC7		200	200	$ 644.8	4,600	0	22,500	22,500	$ 28,658
						500	22,100	22,600	$ 28,531
						1,250	21,100	22,350	$ 28,850
						2,250	19,800	22,050	$ 29,243
						2,750	18,900	21,650	$ 29,783
						3,250	16,400	19,650	$ 32,814
WC8		200	200	$ 659.4	6,850	0	23,600	23,600	$ 27,941
						1,000	22,700	23,700	$ 27,823
						2,250	21,200	23,450	$ 28,119
						3,000	20,000	23,000	$ 28,670
						3,750	18,600	22,350	$ 29,503
						4,500	16,100	20,600	$ 32,010

Bolts Lake									
BL1	Eagle R Bolts	50	0	$ 57.2	1,200	1,000	0	1,000	$ 57,200
Wolcott Reservoir									
WR1	Eagle R Dowds	175	0	$ 373.1	45,000	21,000	0	21,000	$ 17,767

[1] Capital costs associated with Eagle Park Res include seepage improvements below existing dam and new dam, which could be substantially reduced if not required below existing dam. See Table 3-4 for further reference.
[2] Eagle Park Res yields do not include storage allocation for Climax or use of existing 3,300 ac-ft storage. W Slope firm yields would be reduced by approximately 500 ac-ft for every 1,500 ac-ft of Eagle Park Res storage allocated to Climax. Recent model simulations of existing Eagle Park Res system result in existing W Slope firm yield of 1,750 ac-ft, which may differ from previous estimates by others due to recent hydrology/model refinements. Total yield estimates may represent best case; actual future operational mitigation strategies may substantially reduce yield.

Yield and cost results presented in **Table 4-2** for Eagle Park Reservoir and for Whitney Creek Reservoir are shown graphically on **Figure 4-1** and **Figure 4-2**, respectively, which are intended to illustrate the potential balance between West Slope firm yield and East Slope average yield that may be obtained through alternative operational strategies.

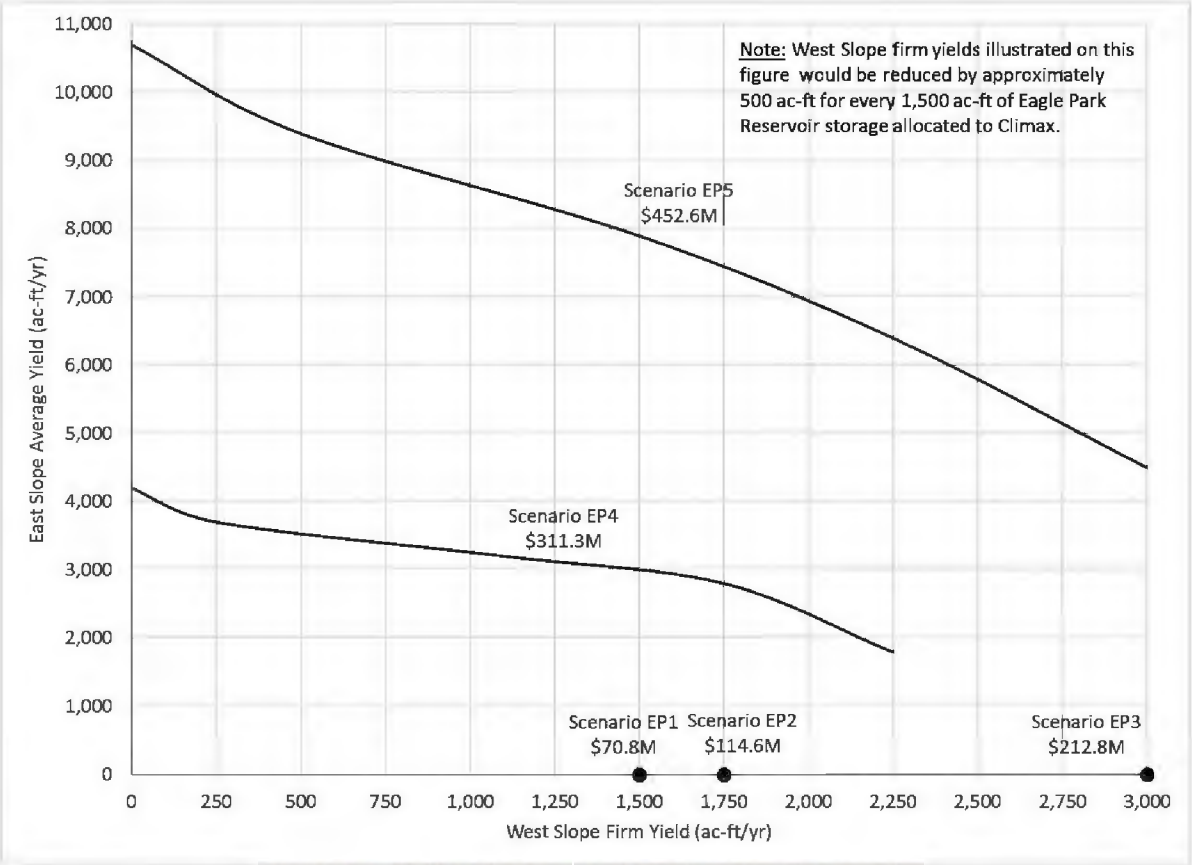

Figure 4-1. Yield Estimates – Eagle Park Reservoir Scenarios

As an example, illustrated on **Figure 4-1**, Scenario EP2 (enlarged 7,950 ac-ft reservoir and enlarged 50 cfs pump station with water supply from the East Fork Eagle River, costing an estimated $114.6 million) could attain up to 1,750 ac-ft/yr of new West Slope firm yield with no average yield allocated to the East Slope. Alternatively, as also illustrated on **Figure 4-1**, Scenario EP5 (enlarged 7,950 ac-ft reservoir and new 150 cfs pump station with water supply from the Eagle River below Resolution Creek, costing an estimated $452.6 million) could attain up to 3,000 ac-ft/yr of new West Slope firm yield combined with approximately 4,500 ac-ft/yr of new East Slope average yield.

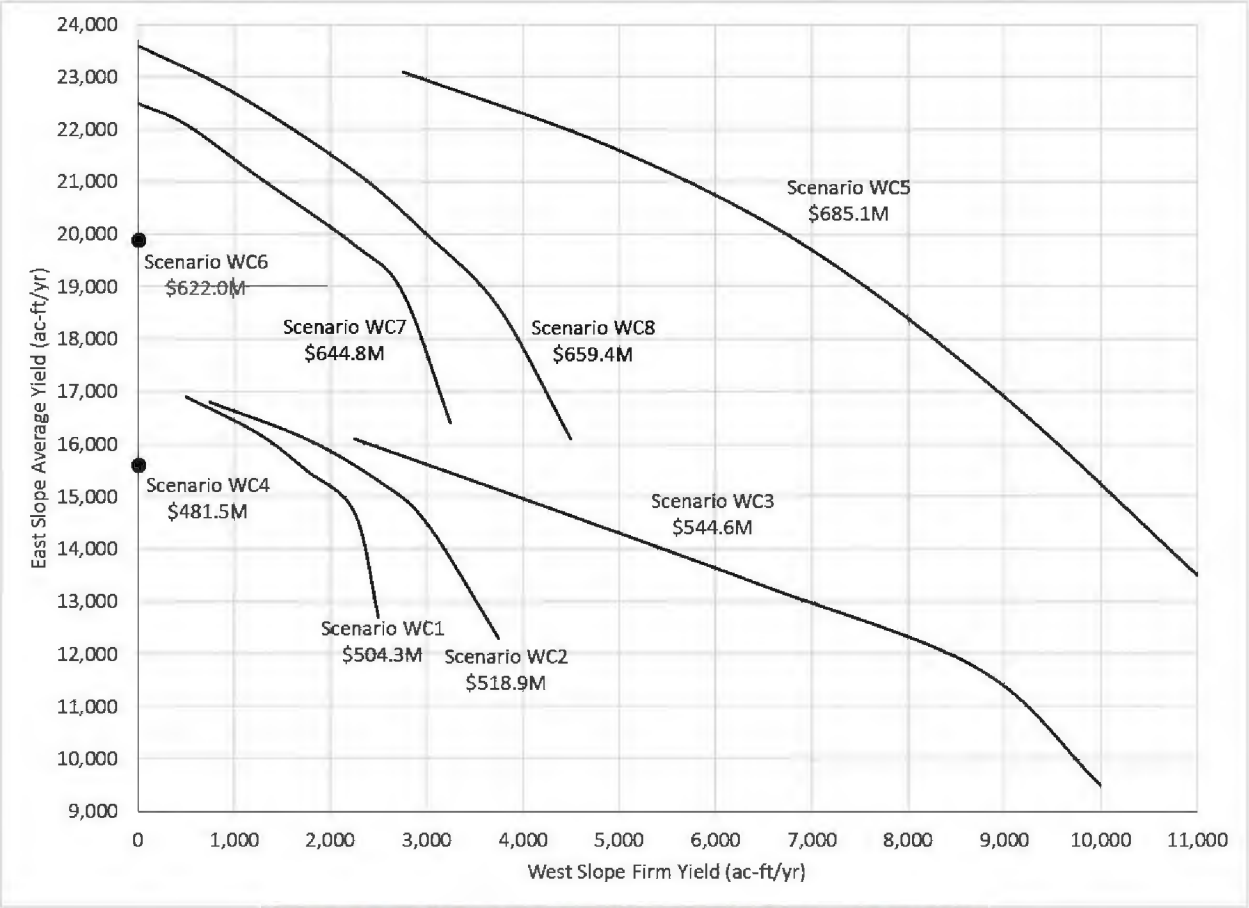

Figure 4-2. Yield Estimates – Whitney Creek Reservoir Scenarios

As an example illustrated on **Figure 4-2**, Scenario WC6 (relatively small off-channel forebay system with channel gravity-fed water supplies from Homestake Creek and tunnel gravity-fed water supplies from the Eagle River and Fall/Peterson Creeks, costing an estimated $622.0 million) could attain nearly 20,000 ac-ft/yr of East Slope average yield with no firm yield allocated to the West Slope. Alternatively, as also illustrated on **Figure 4-2**, Scenario WC5 (relatively large on-channel reservoir system with similar supplies as Scenario WC6, costing an estimated $685.1 million) could attain nearly 20,000 ac-ft/yr of East Slope average yield combined with approximately 7,000 ac-ft/yr of West Slope firm yield.

4.3.2 Portfolio Cost/Yield Estimates

The previous section presented cost/yield results for multiple variations of project scenarios to assess their potential to individually contribute to ERMOU objectives. This section presents cost/yield results for project portfolios to assess the potential for multiple scenarios to collectively contribute to ERMOU objectives.

Twelve project portfolios were evaluated with the same daily simulation model (described in **Section 4.1**) that was used to estimate yields for project scenarios in the previous section. These portfolios include operational variations of Eagle Park Reservoir, Whitney Creek Reservoir, and Bolts Lake; the portfolios do not include Wolcott Reservoir as it is a major facility that could be used exclusively and independently to exceed the entire ERMOU West Slope firm yield objective. The key assumption used to estimate portfolio yields with the simulation model is that a volume of water that is stored at an

upstream facility (e.g. Eagle Park Reservoir), and released from that upstream storage facility for ERMOU objectives, is no longer available for diversion and storage at another facility (e.g. Whitney Creek Reservoir), so as to not double account water available for ERMOU purposes. Listed below are descriptions of the portfolios evaluated.

Portfolios 1-6 include a common Eagle Park Reservoir configuration (**EP1**) with varying configurations of Whitney Creek Reservoir (**Scenarios WC4, WC6, WC1, WC2, WC3, and WC5**) to represent incrementally increasing levels of expected yield and incrementally increasing levels of expected environmental impacts associated with Whitney Creek Reservoir alternatives.

- **Portfolio 1** combines **Scenarios EP1 and WC4**. An enlarged Eagle Park Reservoir (**7,950 ac-ft**) would receive water from the existing pump station and pipeline (**6 cfs**) located on the East Fork Eagle River. A relatively small off-channel Whitney Creek Reservoir (**1,000 ac-ft**) would receive water from Homestake Creek, and from the Eagle River below Resolution Ck through a new tunnel (**200 cfs**), and water would be transferred from Whitney Creek Reservoir to Homestake Reservoir with a new pump station/pipeline (**200 cfs**).

- **Portfolio 2** combines **Scenarios EP1 and WC6** (same configuration as Portfolio 1 except the 1,000 ac-ft off-channel Whitney Creek Reservoir would also receive water from Fall and Peterson Creeks through a new tunnel of **200 cfs**).

- **Portfolio 3** combines **Scenarios EP1 and WC1** (same configuration as Portfolio 1 except Whitney Creek Reservoir would be **4,600 ac-ft**).

- **Portfolio 4** combines **Scenarios EP1 and WC2** (same configuration as Portfolio 1 except Whitney Creek Reservoir would be **6,850 ac-ft**).

- **Portfolio 5** combines **Scenarios EP1 and WC3** (same configuration as Portfolio 1 except Whitney Creek Reservoir would be **20,000 ac-ft**).

- **Portfolio 6** combines **Scenarios EP1 and WC5** (same configuration as Portfolio 5 except the 20,000 ac-ft Whitney Creek Reservoir would also receive water from Fall and Peterson Creeks through a new tunnel of **200 cfs**).

Portfolios 7-10 include a common Whitney Reservoir configuration (**WC6**) as Portfolio 2 (**1,000 ac-ft** off-channel Whitney Creek Reservoir with added water supply from Fall and Peterson Creeks) with varying configurations of Eagle Park Reservoir (**Scenarios EP2, EP3, EP4, and EP5**) to represent incrementally increasing levels of expected yield and incrementally increasing levels of expected environmental impacts associated with Eagle Park Reservoir alternatives.

- **Portfolio 7** combines **Scenarios EP2 and WC6** (same configuration as Portfolio 2, except the existing pump station and pipeline on the East Fork Eagle River would be replaced with an enlarged conveyance system of **25-50 cfs** to supply Eagle Park Reservoir).

- **Portfolio 8** combines **Scenarios EP3 and WC6** (same configuration as Portfolio 7, except the existing pump station and pipeline on the East Fork Eagle River would be replaced with a new pump station and pipeline of **40 cfs** from the Eagle River below Resolution Creek to supply Eagle Park Reservoir).

- **Portfolio 9** combines **Scenarios EP4 and WC6** (same configuration as Portfolio 7, except the existing pump station and pipeline on the East Fork Eagle River would be replaced with a new pump station and pipeline of **100 cfs** from the East Fork Eagle River below Jones Gulch to supply Eagle Park Reservoir, and water could be transferred from Eagle Park Reservoir to Chalk Creek in the Arkansas River basin with a new pump station and pipeline of **50 cfs**).

- **Portfolio 10** combines **Scenarios EP5 and WC6** (same configuration as Portfolio 7, except the existing pump station and pipeline on the East Fork Eagle River would be replaced with a new pump station and pipeline of **150 cfs** from the Eagle River below Resolution Creek to supply Eagle Park Reservoir, and water could be transferred from Eagle Park Reservoir to Chalk Creek in the Arkansas River basin with a new pump station and pipeline of **50 cfs**).

Portfolios 11 and 12 represent the same configurations as Portfolios 7 and 8, respectively, except each Portfolio would also include an upgraded Bolts Lake (**1,200 ac-ft**) that would receive water from a new pump station and pipeline (**50 cfs**) from the Eagle River.

- **Portfolio 11** combines **Scenarios EP2, WC6, and BL1**.
- **Portfolio 12** combines **Scenarios EP3, WC6, and BL1**.

Each portfolio was evaluated with three variations of Eagle Park Reservoir storage capacity allocated to Climax as follows.

- **Variation 1:** No storage in Eagle Park Reservoir allocated to Climax
- **Variation 2:** 1,500 ac-ft of storage in Eagle Park Reservoir allocated to Climax
- **Variation 3:** 3,000 ac-ft of storage in Eagle Park Reservoir allocated to Climax

Each of the portfolio/variation combinations described above was evaluated for potential ERMOU yield objectives and combined with cost opinions presented in **Section 3.3**. Portfolio cost/yield estimates are presented in **Table 4-3**. Specific portfolios (3-6, 9, and 10) each include five cost/yield estimates to represent a range of yield ratios balanced between West Slope and East Slope uses. Model simulations indicate that West Slope firm yields presented in **Table 4-3** would be reduced by approximately 500 ac-ft for every 1,500 ac-ft of Eagle Park Reservoir storage allocated to Climax.

Table 4-3. Cost/Yield Estimates – ERMOU Portfolios

Portfolio	Scenarios	Capital Cost ($M)[1]	New Storage (ac-ft)	New Annual Yield[2] (ac-ft/yr)			Cost/Yield ($/ac-ft)
				W. Slope Firm	E. Slope Average	Total	
1	EP1+WC4	$552.3	5,650	1,550	13,000	14,550	$37,959
2	EP1+WC6	$692.8	5,650	1,550	17,200	18,750	$36,949
3	EP1+WC1	$575.1	9,250	2,050	16,200	18,250	$31,512
				2,800	15,500	18,300	$31,426
				3,250	14,900	18,150	$31,686
				3,550	14,400	17,950	$32,039
				4,050	12,300	16,350	$35,174
4	EP1+WC2	$589.7	11,500	2,250	16,100	18,350	$32,136
				3,250	15,400	18,650	$31,619
				4,050	14,700	18,750	$31,451
				4,550	14,000	18,550	$31,790
				5,250	11,800	17,050	$34,587
5	EP1+WC3	$615.4	24,650	3,750	15,300	19,050	$32,304
				5,800	14,100	19,900	$30,925
				8,050	12,600	20,650	$29,801
				10,250	11,000	21,250	$28,960
				12,050	8,800	20,850	$29,516
6	EP1+WC5	$755.9	24,650	4,300	22,500	26,800	$28,205
				6,550	20,900	27,450	$27,537
				8,550	19,300	27,850	$27,142
				10,550	16,600	27,150	$27,842
				12,550	13,200	25,750	$29,355
7	EP2+WC6	$736.6	5,650	1,750	19,600	21,350	$34,501
8	EP3+WC6	$834.8	5,650	3,000	18,200	21,200	$39,377
9	EP4+WC6	$933.3	5,650	0	22,400	22,400	$41,665
				250	22,000	22,250	$41,946
				1,000	21,500	22,500	$41,480
				1,750	21,000	22,750	$41,024
				2,250	20,200	22,450	$41,572
10	EP5+WC6	$1,074.6	5,650	0	23,900	23,900	$44,962
				500	22,800	23,300	$46,120
				1,500	21,600	23,100	$46,519
				2,250	20,700	22,950	$46,824
				3,000	20,000	23,000	$46,722
11	EP2+WC6+BL1	$793.8	6,850	2,750	19,500	22,250	$35,676
12	EP3+WC6+BL1	$892.0	6,850	4,000	18,200	22,200	$40,180

[1] Capital costs associated with Eagle Park Res include seepage improvements below existing dam and new dam, which could be substantially reduced if not required below existing dam. See Table 3-4 for further reference.

[2] Eagle Park Res yields do not include storage allocation for Climax or use of existing 3,300 ac-ft storage. W Slope firm yields would be reduced by approximately 500 ac-ft for every 1,500 ac-ft of Eagle Park Res storage allocated to Climax. Recent model simulations of existing Eagle Park Res system result in existing W Slope firm yield of 1,750 ac-ft, which may differ from previous estimates by others due to recent hydrology/model refinements. Total yield estimates may represent best case; actual future operational mitigation strategies may substantially reduce yield.

Yield and cost results presented in **Table 4-3** are shown graphically on **Figure 4-3**, which are intended to illustrate the potential balance between West Slope firm yield and East Slope average yield that may be obtained through alternative operational strategies.

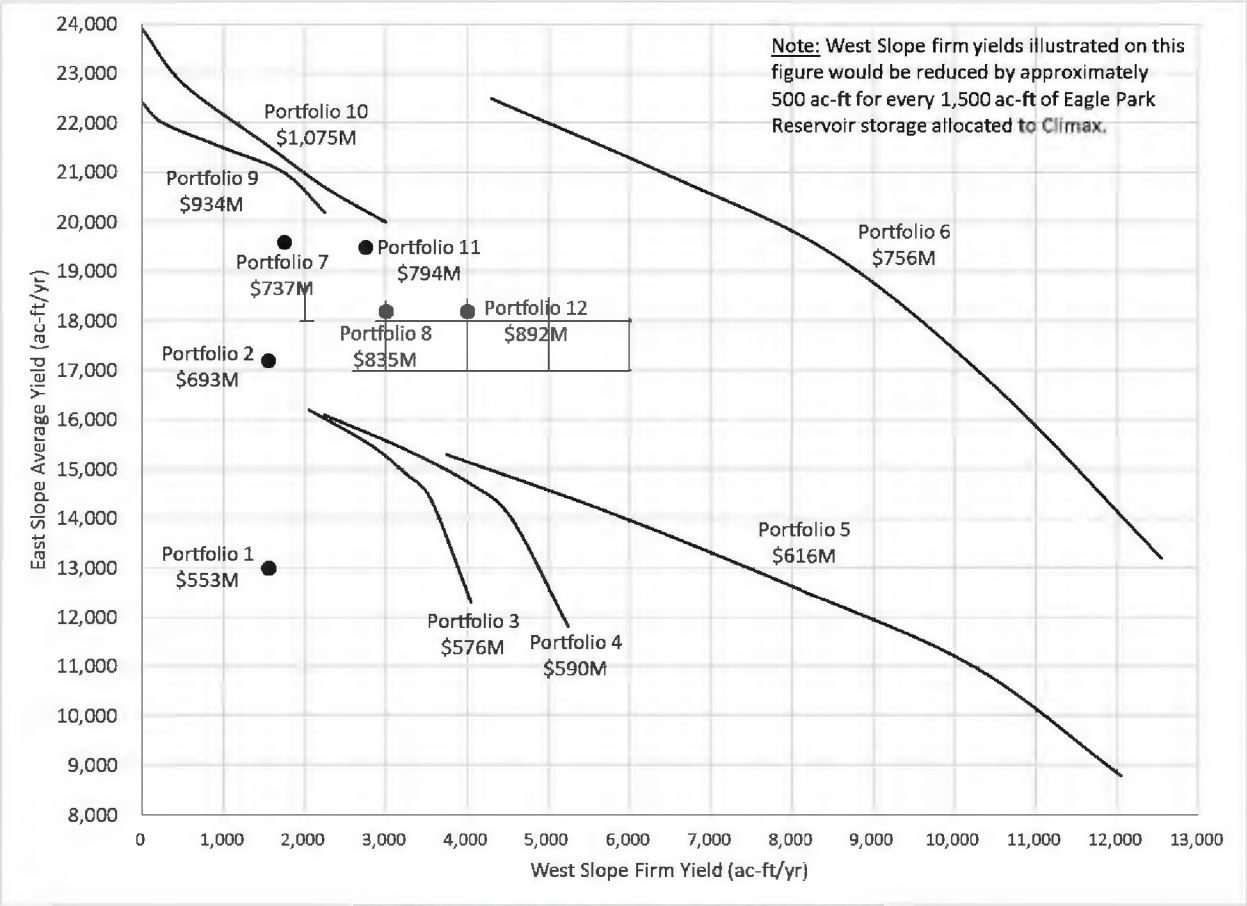

Figure 4-3. Yield Estimates – ERMOU Portfolios

As an example illustrated on **Figure 4-3**, Portfolio 1 (enlarged 7,950 ac-ft Eagle Park Reservoir and existing 6 cfs pump station with water supply from the East Fork Eagle River, combined with a relatively small off-channel Whitney Creek forebay system with channel gravity-fed water supplies from Homestake Creek and tunnel gravity-fed water supplies from the Eagle River, costing a combined estimated $553 million) could attain approximately 13,000 ac-ft/yr of East Slope average yield combined with approximately 1,500 ac-ft/yr of West Slope firm yield. Alternatively, as also illustrated on **Figure 4-3**, Portfolio 5 (the same Eagle Park Reservoir configuration as Portfolio 1, combined with a relatively large on-channel Whitney Creek Reservoir system with similar supplies as Portfolio 1, costing a combined estimated $616 million) could attain the same East Slope average yield as Portfolio 1 (approximately 13,000 ac-ft/yr) combined with approximately 7,000 ac-ft/yr of West Slope firm yield.

Section 5 Evaluations – Environmental Requirements and Issues

Environmental evaluations were completed by LRE with technical input and peer review by WWG and RJH. Work was coordinated with other technical disciplines to provide a basis for and review of environmental evaluations.

5.1 Environmental Permitting Requirements

Development of ERMOU facilities, including dams and reservoirs, pipelines, pump stations, and diversion facilities would require compliance with multiple federal, state, and local regulatory requirements. In most cases, the permitting requirements for the different options considered in the investigation will be nearly the same, but the environmental issues associated with individual facilities could be highly variable depending upon their specific locations and impacts.

The major federal, state, and local permitting and approval requirements for the ERMOU portfolios addressed in this Study are listed and summarized below. Environmental permitting issues and mitigation requirements associated with the individual facilities that comprise the portfolios are described in the following section of the report. **Section 7** presents a summary of previous studies reviewed to support environmental evaluations.

5.1.1 Federal Agencies

USDA Forest Service Special Use Permit and/or Rights-of-Way

Approximately 94% of the Eagle River watershed above Dowds Junction is National Forest System Land in the White River Nation Forest and development of any new water supply facilities on the National Forest land will require a Special Use Permit and/or right-of-way. The Forest Service permitting process would involve preparation of a Special Use Permit Application and an Environmental Assessment (EA) or Environmental Impact Statement (EIS) to meet National Environmental Policy Act (NEPA) compliance requirements. The process consists of an evaluation of the environmental effects of the proposed project including alternatives to the proposed action. There are three levels of analysis depending on whether the proposed project could significantly affect the environment. These three levels include: categorical exclusion determination; preparation of an environmental assessment/finding of no significant impact (EA/FONSI); and preparation of an EIS. The water development and conveyance facilities proposed to meet the goals of the ERMOU will most likely require an EIS.

U.S. Army Corps of Engineers – Section 404 Dredge and Fill Permit

The Army Corps of Engineers regulates discharge of dredged and fill material into Waters of the United States under the authority of the Clean Water Act (33 USC 1251 Et Seq.). Their regulatory mandate requires the protection of aquatic habitats including wetlands and fisheries. Impacts to wetlands and fisheries that cannot be avoided must be mitigated. The Corps of Engineers may require preparation of an EA or EIS to satisfy their NEPA compliance requirements and make sure that all issues associated with the 404 Permit are properly addressed. It is likely that the water development and conveyance facilities proposed to meet the goals of the ERMOU would require an individual 404 Permit application.

U.S. Environmental Protection Agency – NEPA Review

Under the National Environmental Policy Act (NEPA) (42 USC 4321 Et Seq.), EPA has formal review and approval authority to determine federal agency compliance with the requirements of NEPA. EPA also has broad oversight and veto authority over Section 404 Permit decisions made by the Corps of Engineers (Clean Water Act, Section 404(B)(1) Compliance Review). Oversight issues may include the purpose and need for the proposed project, alternatives, water quality, aquatic habitat impacts, threatened and endangered species, and mitigation. For the ERMOU alternatives, EPA will be primarily concerned with potential wetlands, water quality, and aquatic life impacts.

The 404(B)(1) Guidelines (40 CFR, Part 230) provide the criteria used by the Army Corps of Engineers and EPA for evaluation of discharges of dredged or fill materials to Waters of the United States under Section 404 of the Clean Water Act. The Guidelines emphasize restoration and maintenance of the chemical, physical, and biological integrity of Water of the U.S. by controlling discharges in a manner consistent with the policies expressed in the Clean Water Act. Fundamental to the Guidelines is the precept that discharges of dredged or fill material should be permitted only if such discharge would not cause unacceptable adverse impacts either directly or in combination with the environmental impacts of existing and/or other planned activities.

The 404(b)(1) Guidelines identify a series of restrictions on the discharge of dredged or fill materials. These restrictions include:

- Only the least environmentally damaging practicable alternative (LEDPA) may be permitted. An alternative is assumed to be "practicable" if it is available and capable of being done after consideration of cost, existing technology, and logistics in light of overall project purposes. The Guidelines that the alternatives be evaluated and compared without accounting for potential mitigation measures (40 CFR 230.10(a)).
- A prohibition against any discharge that causes or contributes to violations of state water quality standards or jeopardizes the existence of threatened or endangered species (40 CFR 230.10(b)).
- A prohibition against permitting any discharges that causes or contributes to a significant degradation of Water of the U.S., as demonstrated by evaluations conducted pursuant to Subparts C through G of the Guidelines (40 CFR 230.10(c)).
- A requirement that appropriate and practicable steps be taken to minimize potential adverse impacts before a discharge may be permitted (40 CFR 230.10(d)).

A Section 404 Permit cannot be issued unless a discharge is in compliance with the 404(b)(1) Guidelines.

U.S. Fish and Wildlife Service

Under Section 7 of the Endangered Species Act (16 USC 1531 Et Seq.), the Forest Service (for the Special Use Permit/right-of-way) and the Corps of Engineers (for the 404 Permit) will be required to initiate consultation with the U.S. Fish and Wildlife Service (USFWS) to ensure that threatened and endangered species are not adversely affected by the proposed project. Section 7 Consultation is also a prerequisite to NEPA compliance.

In addition to Section 7 consultation, under the Fish and Wildlife Coordination Act (16 USC 661 Et Seq.), the USFWS is authorized to be involved in the evaluation of impacts to fish and wildlife from water resource development projects. It also requires federal agencies that permit water development projects to consult with the USFWS and the Colorado Parks and Wildlife (CPW) regarding impacts to fish and wildlife and measures to mitigate impacts.

Pursuant to the Fish and Wildlife Act (16 U.S.C. 742(a)-754), the Fish and Wildlife Coordination Act (16 U.S.C. 661-667(e)), the Watershed Protection and Flood Prevention Act (16 U.S.C. 1001-1009), and NEPA (42 U.S.C. 4321-4347), the USFWS has adopted a Mitigation Policy that provides guidance for their development of recommendations for protection and conservation of fish and wildlife resources including measures to mitigation losses of fish, wildlife, and their habitats. The Mitigation Policy identifies four Resource Categories, defines the criteria for Resource Category designations, and establishes mitigation goals for each Resource Category. Federal Register, Vol. 46, No. 15, February 4, 1981.

In 1998, the USFWS designated fen wetlands as a Category 1 resource. The primary designation criteria for Resource Category 1, is "habitat to be impacted is of high quality for evaluation species and is unique and irreplaceable on a national basis or in the ecoregion section." The mitigation goal for habitat in Resource Category 1 is "no loss of existing habitat value." For Resource Category 1 impacts, the Service will recommend that all losses of existing habitat be prevented, as these one-of-a-kind areas cannot be replaced. However, minor impacts that do not result in adverse impacts on habitat value may be acceptable provided they will have no significant cumulative impact.

U.S. Advisory Council on Historic Preservation

Under the National Historic Preservation Act (16 USC 470a Et Seq.), Section 106, federal agencies are required to consult with the State Historic Preservation Office (SHPO) to determine if any permitted activities may adversely affect historic properties. The Office of Archaeology and Historic Preservation is a division of The Colorado Historical Society and serves as the Colorado SHPO. Cultural Resource Clearance from SHPO will be required in conjunction with a Forest Service Special Use Permit, Army Corps of Engineers 404 Permit, and NEPA compliance. The goal is to protect cultural, historic, and archaeological resources in the project area. Permitting agencies may also require a cultural resource survey if areas to be impacted by the project have not been previously disturbed. The ERMOU Portfolios evaluated in this Study all include facilities that would be located in the Camp Hale area. During World War II, Camp Hale was an important training site for the U.S. Army 10th Mountain Division. In 1992, Camp Hale was added to the National Register of Historic Places. Facilities to be located in this area will need to be designed to avoid and minimize impacts to the site and additional mitigation may be required to protect and preserve the site.

5.1.2 State Agencies

The proposed ERMOU project alternatives would not be located on state lands. Therefore, the following list of state permitting requirements does not include a right-of-way that would be required for use of state lands.

Colorado Department of Public Health and Environment (CDPHE) – Water Quality Control Division

Section 401 of the Clean Water Act requires that the federal approvals described above (e.g. the 404 Permit) for construction and operation of the proposed project will not cause violation of state water quality standards. The 401 Certification process may include an antidegradation review to determine whether any decrease in water quality caused by project construction would be within certain limits established by the Colorado Water Quality Control Commission. The Section 401 Certification is a prerequisite to approval of the Section 404 Permit by the U.S. Army Corps of Engineers.

In addition to the 401 Certification, the Water Quality Control Division may also require a Colorado Discharge Permit for any point source discharge anticipated during project construction, such as dewatering. This permit may be obtained by the construction contractor and will most likely require a detailed erosion control plan.

CDPHE – Air Pollution Control Division

Under the Colorado Air Quality Control Act (CRS 25-7-302 Et Seq.) an Air Emissions Permit may be required to control construction related emissions from surface disturbance and construction equipment.

Colorado Parks and Wildlife

Under the Fish and Wildlife Coordination Act, federal agencies are required to consult with local agencies that have responsibility for management of fish and wildlife resources. The Division of Wildlife will work with the U.S. Fish and Wildlife Service in the evaluation of impacts and recommended mitigation measures. In addition, Eagle County will refer the 1041 Permit application to the Division of Wildlife for review and comment.

Though the Division of Wildlife has no formal permitting authority, their comments will be influential in federal, state and local permitting decisions. The issues of concern to the Division would include water quality impacts on aquatic life and potential impacts on wildlife habitat including game migration corridors.

Colorado Water Conservation Board

The Colorado Water Conservation Board (CWCB) Instream Flow and Natural Lake Level Program (ISF) 37-92-102 (3) C.R.S. is responsible for the appropriation, acquisition and protection of instream flow and natural lake level water rights to preserve and improve the natural environment to a reasonable degree. The East Fork of the Eagle River and the Eagle River below Resolution Creek have instream flow water rights (Case Nos. 5-85CW262, 5-85CW263, and 5-85CW263) that could be affected by ERMOU diversion facilities. Under item No. 7, Inundation of ISF Rights, the CWCB Rules state that "Inundation of all or a portion of an ISF stream reach or lake may be an interference with the Board's usufructuray rights." Depending upon the design of the proposed diversion facilities, a request to inundate may need to be submitted to the Board Office with a water court application outlining the storage plans, along with State Engineer approved jurisdictional dam specifications (if applicable). This requirement would not be applicable to Eagle Park Reservoir Enlargement, the Whitney Creek Reservoir alternatives, Bolts Lake,

and Wolcott Reservoir because these facilities would not result in inundation of stream reaches with instream flow water rights.

Colorado Department of Transportation

Permits from the Colorado Department of Transportation would be required for the transportation of construction equipment and fill material to and from the project site if state highways are utilized.

5.1.3 Local Agencies

Eagle County

Eagle County Guidelines and Regulations for Matters of State Interest (the "1041" Regulations) apply to the designation and regulation of any area or activity of state interest wholly or partially in the unincorporated areas of Eagle County whether on public or private land. The proposed sites are all located within Eagle County and will therefore require the submittal of a 1041 application adhering to the guidelines defined in Section 6.03 of the Eagle County Land Use Regulations. The issues that will be of concern to Eagle County will include water quality, aquatic life, wildlife habitat, natural hazards, and other issues.

Town of Minturn

Bolts Lake would be located in the Town of Minturn and the establishment of Bolts Lake has been approved and is included on the Town's zoning map. However, additional Town of Minturn requirements such as such as design review, grading permit and building permits may be required.

5.2 Environmental Permitting Issues

For purposes of this report, environmental permitting issues associated with the individual facilities that comprise the ERMOU alternative portfolios were investigated based upon information readily available from resource databases and previous studies. This assessment of environmental permitting issues should be considered "preliminary" because site specific field investigations have not been conducted to verify the accuracy and completeness of the currently available information.

5.2.1 Wetlands

The alternative ERMOU Portfolios include reservoirs, pipelines, and pump stations that, if constructed, would impact wetlands. For purposes of this report, the preliminary assessment of impacts to wetlands is based upon the National Wetlands Inventory (NWI) developed by the USFWS (2016). The NWI provides GIS coverages of wetland areas that are based upon aerial photography (1 meter or better) and color infrared technology.

The NWI maps generally include wetland and riparian type, size, and approximate boundaries of wetlands including extent, characteristics, and functions of wetlands. The mapped wetlands layers were originally developed and based on imagery from the 1980s. The accuracy of image interpretation depends on the quality of the imagery. However, some field reconnaissance by the USFWS was

conducted in 1993 to verify NWI data and the wetlands boundaries were adjusted based on vegetation and hydrology field observations (USFWS, 2015).

NWI wetland boundaries were further refined for developing estimates of potential impacts of the ERMOU facilities based on review of 2015 aerial imagery and familiarity with the area. Wetland impact area estimates are based upon the following refinements, assumptions, and qualifications:

- Known wetland mitigation sites were added to Eagle Park Reservoir area;
- Riparian wetlands extending out 10 feet on both sides of the stream were added to all small tributaries potentially affected by ERMOU facilities;
- A 75-foot wide disturbance area was assumed for estimation of potential impacts associated with pipelines through wetland areas and at stream crossings;
- Estimates of wetlands impacts include temporary impacts, such as those associated with buried pipelines where it may be possible to restore wetlands after construction;
- Pump station and diversion structure construction footprints are not included in this analysis.
- Estimated wetlands impacts are based upon the potential physical footprints of the facilities and do not include additional potential impacts associated with project operations.

The estimates of potential impacts to wetlands for the ERMOU facilities are summarized below. It is important to note that these estimates only include direct impacts associated with facilities and do not include operations impacts to riparian wetlands associated with streamflow modifications such as peak flow reductions. Additional project specific investigations will be needed to evaluate potential operational impacts.

Eagle Park Reservoir

Wetlands Impacts

The enlargement of Eagle Park Reservoir to an elevation of 10,775 feet (capacity = 7,950 acre-feet) including the construction of new pipelines could impact up to 14.5 acres of wetlands, depending upon the selected pipeline alternatives. **Table 5-1** provides a summary of the wetlands impact areas for the facilities and pipeline options associated with the Eagle Park Reservoir Enlargement.

Table 5-1. Potential Wetlands Impacts – Eagle Park Reservoir

Facility	Potential Wetland Impacts (ac)
Eagle Park Reservoir Enlargement (Elevation = 10,775 ft, Capacity = 7,950 ac-ft)	9.6
Eagle River near Camp Hale to Eagle Park Reservoir Pipeline	1.5
East Fork Eagle River near Jones Gulch to Eagle Park Reservoir Pipeline	0.0
East Fork Eagle River Pump Station to Eagle Park Reservoir	0.0
Upper Pipeline from Eagle Park Reservoir to the Arkansas River	3.4
Eagle Park Reservoir to Chalk Creek Pipeline	2.0
Pipeline from Eagle Park Reservoir to Columbine Ditch Alternative 1	2.1
Pipeline from Eagle Park Res to Columbine Ditch Pipeline Alternative 2	1.9

Figures C-1 and C-2 show the locations of wetlands that would be impacted by the Eagle Park Reservoir enlargement and associated pipelines for conveyance of water to the reservoir from the lower reach of

the East Fork of the Eagle River or the Eagle River and for delivery of water from reservoir to the East Fork of the Arkansas River. The reservoir enlargement and appurtenant facilities would impact freshwater emergent willow scrub and riparian scrub wetlands including three wetland mitigation sites that were established to mitigate wetlands impacts associated with a previous enlargement of the reservoir and the East Fork Pump Station.

Permitting Issues and Mitigation Requirements

Wetlands impacts will need to be carefully addressed in the permitting process, but should not be a significant impediment to permitting, if it can be demonstrated that the proposed project is the least environmentally damaging practicable alternative. Wetlands impacts for the reservoir enlargement would be unavoidable and would require mitigation. The wetlands impacted by the reservoir enlargement are mostly in areas that have been previously disturbed and would probably not be considered high quality wetlands. It is therefore likely that the required mitigation ratio (ratio of mitigation area to impact area) would be at or close to 1:1. It is possible that some of the impacts could be mitigated by establishment of new wetlands along the reservoir shoreline, but this type of mitigation would be limited if significant reservoir drawdown occurs frequently during the summer growing season. The Camp Hale area would probably be the nearest suitable option for off-site mitigation. Wetlands impacts associated with pipelines and pump stations could possibly be avoided or further minimized through refinement of the pipeline routes and pump station locations, but impacts to riparian wetlands at stream crossings would be unavoidable without tunneling under stream, which could significantly increase construction costs. Most of the pipeline related wetland impacts would be temporary because impacted areas can usually be restored after construction.

Whitney Creek Reservoir

Wetlands Impacts

The Whitney Creek Reservoir, dam and associated pipelines and pump stations could impact approximately 26 acres to 180 acres of wetlands, depending on the chosen alternative. **Table 5-2** provides a summary of the wetlands impact areas for the alternative facilities associated with the Whitney Creek Reservoir.

Table 5-2. Potential Wetlands Impacts – Whitney Creek Reservoir

Facility	Potential Wetland Impacts (ac)
Alternative 1: Whitney Reservoir (Elevation = 9,040 ft, Capacity = 4,600 ac-ft)	32.7
Alternative 2: Whitney Reservoir (Elevation = 9,065 ft, Capacity = 6,850 ac-ft)	42.2
Alternative 3: Whitney Reservoir (Elevation = 9,112 ft, Capacity = 20,000 ac-ft)	164.4
Alternative 3: Road Realignment	4.2
Alternative 4: Off-Channel Reservoir (Capacity = 1,000 ac-ft)	15.4
Eagle River near Camp Hale to Whitney Creek Reservoir Pipeline	8.9
Eagle River near Camp Hale to Whitney Creek Reservoir Tunnel	0.0*
Whitney Creek Reservoir to Homestake Reservoir Pipeline	6.8 to 10.5

* A tunnel could require a several-acre waste rock disposal site that may impact wetlands.

Figures C-3, C-4, C-5, and C-6 show the locations of wetlands that would be impacted by the Whitney Creek Reservoir alternatives and pipeline options for conveyance of water from Camp Hale to Whitney Creek Reservoir and to Homestake Reservoir. All the reservoir alternatives and appurtenant pipeline and pumping facilities would impact high quality freshwater emergent willow scrub wetlands, riparian scrub wetlands, and aquatic bed wetlands. It is not known but possible that the wetlands within the areas that would be impacted by the Whitney Creek Reservoir options include fen wetlands, which have been designated as a Category 1 resource by the USFWS. It is recommended that field wetland surveys of potential Whitney Creek Reservoir options be completed to determine if fens are present in the area, and if potential impacts to fens could be avoided or minimized.

Permitting Issues and Mitigation Requirements

Wetlands impacts will be an important issue in the permitting process for the Whitney Creek Reservoir alternatives, and could be a significant permitting risk factor, unless it can be convincingly demonstrated that the proposed project is the least environmentally damaging practicable alternative. Wetlands impacts for the reservoir would be unavoidable but could be minimized with selection of one of the smaller reservoir storage options. Because of the high-quality character of the wetlands, it is likely that the required mitigation would be at a ratio (mitigation area to impact area) greater than 1:1. If impacts areas include fen wetlands, the permitting costs and risk factors would increase significantly.

It is possible that some wetlands impacts could be mitigated by establishment of new wetlands along the reservoir shoreline, but this type of mitigation would be limited if significant reservoir drawdowns occur frequently during the summer growing season. It is likely that the Camp Hale area would be the nearest suitable option for off-site mitigation. Wetlands impacts associated with pipelines and pump stations could possibly be avoided or further minimized through refinement of the pipeline routes and pump station locations. All pipeline alternatives would cross several tributaries including Whitney Creek, French Creek, and Missouri Creek, and impacts to riparian wetlands at stream crossings would be unavoidable without tunneling under streams, which could significantly increase construction costs. Most of the pipeline related wetland impacts would be temporary because impacted areas can usually be restored after construction.

Bolts Lake

Wetlands Impacts

The construction of Bolts Lake, a diversion facility and pipeline to convey water from the Eagle River to the reservoir, and an outlet pipeline for release of water back to the Eagle River would impact up to 11.3 acres of wetlands. **Table 5-3** provides a summary of the wetlands impact areas for the facilities associated with Bolts Lake.

Table 5-3. Potential Wetlands Impacts – Bolts Lake

Facility	Potential Wetland Impacts (ac)
Bolts Lake (Elevation = 8,140 ft, Capacity = 1,210 ac-ft)	11.3*
Diversion No. 2 Pipeline (3,600 feet upstream)	0.3
Diversion No. 3 Pipeline (adjacent to reservoir)	0.01

* Wetlands in the Bolts Lake inundation area may be non-jurisdictional.

Figure C-7 shows the locations of the wetlands that could be impacted by the construction of Bolts Lake and the alternative diversion and outlet facilities. Bolts Lake and much of the surrounding area has been previously disturbed by construction of the original Bolts Lake Reservoir and mining and reclamation activities associated with the Eagle Mine Superfund Site. Wetlands in this area are freshwater willow scrub/shrub, emergent, and riparian scrub wetlands. In 2010 and 2011, Claffey Ecological Consulting completed a delineation of wetlands in the Bolts Lake area and an assessment of the jurisdictional status of the wetlands, which found that the wetlands located in the original reservoir basin are non-jurisdictional. It is understood that the Corps of Engineers agrees with the finding of the Claffey report, but that no agency has made a final jurisdictional determination. If this the non-jurisdictional determination is confirmed, the potential wetlands impacts associated with Bolts Lake would be less than 0.4 acres.

Historically, the water supply for Bolts Lake was diverted from Cross Creek at a location that is on Forest Service land within the Holy Cross Wilderness Area. Rehabilitation of the diversion facility on Cross Creek and the conveyance channel from Cross Creek to Bolts Lake would result in additional impacts to wetlands. Additional investigations beyond the scope of this Study would be required to estimate potential wetlands impacts.

Permitting Issues and Mitigation Requirements

Wetlands impacts associated with the development of Bolts Lake appear to be minimal, and should not be a significant risk factor in the permitting process. If the wetlands in the reservoir basin are non-jurisdictional, wetlands impacts would be limited to riparian areas adjacent to the Eagle River at the proposed intake and outfall structures. It is important to note that even if the Army Corps of Engineers and EPA find that the Bolts Lake wetlands are non-jurisdictional, other permitting agencies, such as Eagle County or the Town of Minturn could require mitigation. These wetlands would probably not be considered high quality wetlands and it is likely that the required mitigation ratio (ratio of mitigation area to impact area) would be at or close to 1:1. It is very likely that all the impacts could be mitigated

on-site with establishment of new wetlands along the reservoir shoreline or in the area to the west of the reservoir.

Bolts Lake and the associated diversion and outfall facilities appear to be located entirely on private land within the Town of Minturn, indicating that no Forest Service permitting and no Eagle County 1041 permitting would be required unless the project included rehabilitation of the diversion from Cross Creek. The Forest Service typically requires that when wetlands impacts occur on Forest land, the mitigation must be located on Forest land.

Wolcott Reservoir

Wetlands Impacts

The development of Wolcott Reservoir with a storage capacity of 55,000 acre-feet and a pipeline from Dowds Junction to the reservoir would impact up to 113 acres of wetlands. **Table 5-4** provides a summary of the wetlands impact areas for the facilities and pipeline options associated with Wolcott Reservoir.

Table 5-4. Potential Wetlands Impacts – Wolcott Reservoir

Facility	Potential Wetland Impacts (ac)
Wolcott Reservoir (Elevation = 7,370 ft, Capacity = 55,000 ac-ft)	101.5
Eagle River near Alkali Creek to Wolcott Reservoir Pipeline	0.1
Eagle River near Dowds Junction to Wolcott Reservoir Pipeline	11.1

Figure C-8 shows the locations of wetlands that could be impacted by the construction of Wolcott Reservoir and the pipeline from the Eagle River near the confluence of Alkali Creek to the reservoir. **Figure C-9** shows the locations of wetlands that could be impacted by the pipeline from the Eagle River near Dowds Junction to Wolcott Reservoir. The reservoir would inundate freshwater emergent wetlands and riparian wetlands located along Muddy Creek, Alkali Creek, and unnamed tributary drainages. The quality and condition of the wetlands located in the reservoir inundation area is not known, but it is likely that some of these wetlands have been impacted or degraded by livestock grazing.

Permitting Issues and Mitigation Requirements

Wetlands impacts will be an important issue in the permitting process for the Wolcott Reservoir, and could be a significant permitting risk factor, unless it can be convincingly demonstrated that the proposed project is the least environmentally damaging practicable alternative. Wetlands impacts for the Reservoir would be unavoidable but could be reduced if a smaller reservoir storage alternative is feasible. Additional investigations will be required to better define the quality and characteristics of the wetlands in the Wolcott area, but it is likely that the required mitigation would be at a ratio (mitigation area to impact area) of at least 1:1. If impacts areas include fen wetlands, the permitting costs and risk factors would increase significantly.

It is likely that some wetlands impacts could be mitigated by establishment of new wetlands along the reservoir shoreline, but this type of mitigation would be limited if significant reservoir drawdowns occur frequently during the summer growing season. Additional investigations will be needed to evaluate on

site mitigation potential and off-site mitigation opportunities such as Camp Hale. Wetlands impacts associated with pipelines and pump stations could possibly be avoided or minimized through refinement of the pipeline routes and pump station locations. All pipeline alternatives would cross multiple Eagle River tributaries, and impacts to riparian wetlands at stream crossings would be unavoidable without tunneling under streams, which could significantly increase construction costs. Most of the pipeline related wetland impacts would be temporary because impacted areas can usually be restored after construction.

5.2.2 Wilderness and Roadless Areas

The Upper Eagle River watershed above the confluence of Gore Creek encompasses an area of 166,458 acres and is 93% federal land managed by the U.S. Forest Service. Under current land management status, 39% of the Upper Eagle River watershed is included in the Holy Cross Wilderness Area, which was designated by Congress in 1980. In addition to the Holy Cross Wilderness, 37,659 acres of Forest Service land in the Upper Eagle River watershed is designated as "Roadless Areas" that potentially meet the criteria for wilderness designation with land management restrictions that are similar to wilderness. The overriding management principle in wilderness is "to ensure that human influence does not impede the free play of natural forces or interfere with natural successions in the ecosystems and to ensure that each wilderness offers outstanding opportunities for solitude or a primitive and unconfined type of recreation." (Forest Service Manual, FSM 2300 Chapter 2320)

The Wilderness Act (16 U.S.C. 1131-1136) requires Congressional approval for wilderness boundary modifications. The Act also includes a provision that allows Presidential authorization for the "establishment and maintenance of reservoirs, water conservation works, power projects, transmission lines, and other facilities needed in the public interest" within wilderness areas, "upon his determination that such use or uses in the specific area will better serve the interest of the United States and the people thereof than will its denial."

The Colorado Roadless Rule (36 CFR Part 294) restricts or prohibits the following activities in designated Roadless Areas: tree cutting, sale, or removal; road construction and reconstruction; and linear construction zones (e.g. electrical power lines, pipelines, and telecommunication lines). However, exceptions to the Rule are allowed where these activities are found to be consistent with the applicable Forest Plan land management plan directives. Exceptions to the prohibition of pipelines may be authorized in a Roadless area if the Regional Forester determines that the project is needed pursuant to a reserved or outstanding right, or for construction or reconstruction of a previously authorized facility with an existing water court decree.

Eagle Park Reservoir

The Roadless Areas in the Upper Eagle River Basin that would be affected by the Eagle Park Reservoir Enlargement and associated facilities are shown on **Figure C-13**. The reservoir enlargement, would be located entirely on private land and would not affect any Forest Service Roadless Areas. None of the pipeline alternatives for conveyance of water from the East fork of the Eagle River below Jones Gulch or the Eagle River at Camp Hale to the Eagle Park Reservoir and from the reservoir to the East Fork of the Arkansas River would impact Roadless Areas.

Whitney Creek Reservoir

Whitney Creek Reservoir is the only facility considered in this Study that could potentially infringe upon the Holy Cross Wilderness, where permitting would require modification of the boundary to eliminate any conflicts, depending upon the reservoir size and location.

Table 5-5, shows the minimum areas of infringement associated with alternative storage capacities at the Whitney Creek Reservoir sites. The estimated wilderness infringement areas are characterized as "minimum" because they are based solely upon the location of the reservoir shoreline at the maximum normal pool elevations as shown on **Figures C-10, C-11, and C-12**, for Alternatives 1, 2, and 3, respectively, and do not include buffer areas, access to trail heads, or other wilderness boundary modifications that may be required for Forest Service management purposes Alternative 4 would not conflict with the wilderness boundary. It is important to note that under Alternatives 2 and 3, there could be additional wilderness impacts associated with realignment of Homestake Reservoir Road unless the road could be relocated to the southeast side of the reservoir.

Table 5-5. Alternatives and Minimum Wilderness Impacts – Whitney Creek Reservoir

Alternative	Maximum Normal Pool		Minimum Wilderness Infringement (ac)*
	Elevation (ft)	Capacity (ac-ft)	
1	9,040	4,600	0.00
2	9,065	6,850	1.92
3	9,112	20,000	9.63
4	9,050	1,000	No infringement

* Represents estimated inundation area at maximum normal pool elevation

The Roadless Areas in the Upper Eagle River Basin that would be affected by the Whitney Creek Reservoir and associated facilities are shown on **Figure C-14**. All four of the reservoir alternatives would be located within a currently designated Roadless Area. The pipeline from Camp Hale to the Whitney Creek Reservoir and from the reservoir to Homestake Reservoir would not conflict with Roadless Areas, expect possibly in the areas adjacent to the off-channel reservoir (Alternative 4). The tunnel to convey water from Camp Hale to Whitney Creek Reservoir would be under ground and should not conflict with the Roadless Area. For Alternatives 1, 2, and 3, realignment of the Homestake Reservoir Road to the east of Whitney Creek Reservoir would also conflict with the Roadless Area.

Activities and proposed developments in Roadless Areas may result in a higher level of permitting review scrutiny and controversy. Any Roadless Area conflict, particularly if combined with a wilderness boundary conflict, may generate strong opposition and could therefore create a significant permitting risk factor. Mitigation and negotiation strategies could include the acquisition and protection of private lands including National Forest inholdings or possibly agreements to support additional wilderness designations.

Bolts Lake

Bolts Lake with the proposed diversion and outfall facilities to and from the Eagle River would be located entirely on private lands and would not conflict with any designated Roadless Areas, as shown on **Figure C-15**. If Cross Creek is used as a source of supply for Bolts Lake, the historic point of diversions for Bolts

Ditch is located on Forest Service land in the Holy Cross Wilderness Area, and congressional approval may be required to reestablish the diversion facility and ditch.

Wolcott Reservoir

Wolcott Reservoir would mostly be located on private lands and portions of the dam and reservoir would be located on Bureau of Land Management (BLM) land. The proposed pipeline facilities from the Eagle River near Dowds Junction and the Eagle River near the Alkali Creek confluence would be located mostly on private lands but would also cross Forest Service, BLM and State of Colorado School lands. None of these facilities would conflict with any designated Roadless Areas, as shown on **Figure C-16**.

5.2.3 U.S. Forest Service – Forest Management Areas

The White River National Forest (WRNF) Land and Resource Management Plan (Forest Plan) provides Guidance to the Forest Service for all resource management activities and establish specific management areas. The Forest Plan includes forest-wide standards and guidelines for the protection and management of forest resources (e.g., water and riparian resources, soils, wildlife, etc.) that apply to all areas within the WRNF. It also establishes specific management areas where different prescribed management activities may be carried out and where different kinds of public uses may occur, subject to additional standards and guidelines that are specific to the prescribed management activities.

Site-specific project decisions must be consistent with the Forest Plan. Resource plans and permits, contracts, and other instruments issued for the use and occupancy of National Forest System lands must be consistent with the Forest Plan, unless specifically exempted from applicability in an amendment or revision decision document. The applicable White River Nation Forest Management Areas that would be affected by potential ERMOU facilities are summarized below.

Eagle Park Reservoir

The Eagle Park Reservoir Enlargement would be located on private land owned by the Eagle Park Reservoir Company and the Climax Mine. The pipeline alternatives for delivery of water from the East Fork of the Eagle River below Jones Gulch and the Eagle River at Camp Hale would be located within Management Area 8.32 Designated Utility Corridors, Existing and Potential. These facilities, including pump stations and diversion facilities are consistent with the forest management guideline pertaining to infrastructure. It is not likely that any changes to the Forest Plan would be required for these facilities and consistency with the Forest Plan should not be a significant issue in the permitting process. See **Figure C-13**.

The National Forest Foundation (NFF), in cooperation with the U.S. Forest Service, has developed a plan for restoration of 5 miles of natural stream meanders and approximately 270 acres of riparian wetlands along the Eagle River through Camp Hale. The plan also includes improvement to campgrounds, trailheads, and other recreation facilities in the Camp Hale area. The design for the stream and wetlands restoration and the design and operation of a project to enlarge Eagle Park Reservoir will need to be coordinated and mutually compatible.

The pipeline alternatives for delivery of water from the reservoir to the East Fork of the Arkansas River would cross lands in the San Isabel National Forests that are designated for Semi Primitive Motorized Recreation and Outdoor Recreation-Road Areas, as shown on **Figure C-13**. The pipeline facilities may be compatible with the currently applicable standards and guidelines pertaining to activities and infrastructure in these Management Areas. The impacts associated with the pipeline options would be temporary, because the pipelines would be buried. It therefore appears that Forest Plan amendments would not be needed to approve these uses.

Whitney Creek Reservoir

Inundation associated with two (WC2 and WC3) of the four Whitney Creek Reservoir Alternatives, and construction associated with one (WC3) of the four Whitney Creek Reservoir Alternatives, would be located in Forest Management Area 1.11 Pristine Wilderness; all four of the Whitney Creek Reservoir Alternatives would be located in Forest Management Area 5.41 Deer and Elk Winter Range, as shown on **Figure C-14**. Infrastructure guidelines for these Management Areas do not allow development of reservoirs and new roads and Forest Plan amendments would be required to change the Management Area designations. These changes to the Forest Plan could be controversial. Incompatibility of these facilities with the Forest Plan could present a significant permitting risk factor.

The pipeline from Camp Hale to Whitney Creek Reservoir would be located in the following designated Management areas: 3.1 Special Interest Areas Emphasis of Use; 8.32 Designated Utility Corridors, Existing and Potential; 4.23 Scenic Byways Areas or Travel Corridors; and 5.41 Deer and Elk Winter Range, as shown on **Figure C-14**. The east end of the Tunnel option would be in Management Area 4.23 Scenic Byways Areas or Travel Corridors. The pipeline from Whitney Creek Reservoir to Homestake Reservoir would cross through the following Management Areas 5.41 Deer and Elk Winter Range, and 3.1 Special Interest Areas Emphasis of Use. Infrastructure guidelines for these Management Areas, apart from 8.32, do not allow development of pipelines, pump stations, and waste rock disposal facilities. Forest Plan amendments would be required to change the Management Area designations and such changes could be controversial. Incompatibility of these facilities with the Forest Plan could present a significant permitting risk factor.

Facilities located in Camp Hale would also need to be designed and operated for compatibility with the Camp Hale restoration project, as described above for the Eagle Park Reservoir Enlargement.

Bolts Lake

Bolts Lake with the proposed diversion and outfall facilities to and from the Eagle River would be located entirely on private lands and would not affect any Forest Plan Management Areas, as shown on **Figure C-15**.

Wolcott Reservoir

Wolcott Reservoir would mostly be located on private lands and portions of the dam and reservoir would be located on Bureau of Land Management (BLM) Land. The potential pipeline from the Eagle River near Dowds Junction may cross a parcel of Forest Service Land near Avon, which is currently a designated utility corridor (Management Area 8.32). It is not likely that any changes to the BLM and

Forest Service land management plans would be required for Wolcott Reservoir and appurtenant facilities and consistency with the land management plans should not be a significant issue in the permitting process (see **Figure C-16**).

5.2.4 Wildlife Habitat and Fisheries

Wildlife habitat in the upper Eagle River Basin is generally representative of the habitat found throughout the upper montane and sub-alpine life zones in the White River National Forest. Specific habitats in the project area include subalpine meadow, riparian wetlands, and lodgepole pine and Engelmann spruce subalpine fir communities which occupy the 8,000 to 11,000-foot elevation zone. These habitats provide for a diverse assemblage of both game and non-game wildlife. Large mammals most likely to use the project area are elk, mule deer, black bear, mountain lion, and bighorn sheep. Small mammals found in the project area include southern red-backed voles, least chipmunks, long-tailed voles, northern pocket gophers, red squirrels, snowshoe hares, red fox, coyotes, pine martin, and ermine. Common birds associated with sub-alpine life zones include dark-eyed juncos, American robins, ruby-crowned kinglets, yellow-rumped warblers, pine siskins, hermit thrushes, mountain chickadees, sharp shinned hawk, red tailed hawk, ptarmigans, and blue grouse. Raptors include Golden eagles, northern goshawks, boreal owls and great-horned owls. In the Wolcott area, there is important habitat for the greater sage grouse, which has been identified as a species of special concern by the CPW.

Many of the mammals and birds that may use the area are present only during late spring and summer and migrate to winter ranges that are located outside of the project area. Reptiles and amphibians are poorly represented in the project area due to the high elevation. Fish species found in the Eagle River basin include cutthroat trout, brook trout, Brown trout, rainbow trout, and sculpin.

The primary concerns of the USFWS and the CPW will be potential impacts to wildlife and aquatic life associated with construction and operation of the proposed ERMOU facilities. Construction related impacts would include loss of habitat and wildlife disturbance in the areas where reservoirs, pipelines, and pump stations would be located, and the potential discharge of pollutants such as sediment. Project operational impacts include changes in streamflows, water quality, and disturbance of wildlife caused by human activities associated with operations and maintenance of facilities.

Site-specific NEPA compliance documentation for the proposed ERMOU facilities will require detailed assessment of potential impacts for all wildlife species of concern. For purposes of this Study, potential issues were identified associated with impacts to habitat for elk and deer based upon habitat mapping that is readily available from CPW. Elk and deer habitat mapping information were obtained from the CPW Species Activity Mapping (SAM) study, which was conducted by CPW field personnel. Data was captured using topographic maps and National Agriculture Imagery Program (NAIP) imagery at various scales. These data are updated on a four-year rotation with one of the four CPW regions updated each year. The following describe the impacts on deer and elk for each project alternative.

Eagle Park Reservoir

Eagle Park Reservoir Enlargement, the pipeline options for delivery of water to the East Fork of the Arkansas River, and the upper portion of the pipeline from the Camp Hale area are located in deer and

elk overall range, as shown on **Figures C-17 and C-18**, respectively. Overall range is defined as the area which encompasses all known deer and elk seasonal activity areas. Mitigation may be required for any impacts to deer and elk habitat, but winter range and migration corridors will be the areas of greatest concern.

Portions of the pipelines from the East Fork of the Eagle River and Eagle River near Camp Hale to Eagle Park Reservoir are located within severe elk winter range and a winter concentration area. Severe winter range and winter concentrations are where 90 percent of the elk population is located when the annual snow pack is at its maximum and/or temperatures are at a minimum in the two worst winters out of ten. The winter concentration area is where elk densities are at least 200% greater than the surrounding winter range density during the average five winters out of ten from the first heavy snowfall to spring green-up, or during periods when winter conditions are particularly severe. These areas are considered critical habitat for maintaining a healthy elk population.

Construction of the pipelines in the elk winter range areas at Camp Hale would reduce the amount of available habitat during construction and for a period of several years after construction pending reestablishment of habitat and forage vegetation. While these impacts could be considered temporary, they will be significant issues to be addressed in the permitting process. Mitigation of potential impacts could include the enhancement of forage conditions in other winter range areas, enhanced restoration of the disturbed areas, and acquisition and protection of winter range located on private lands in the project vicinity.

Whitney Creek Reservoir

All Whitney Creek Reservoir alternatives, the Eagle River near Camp Hale to Whitney Creek Reservoir pipeline, and the eastern terminus of the Eagle River near Camp Hale to Whitney Creek Reservoir tunnel are located in overall deer range, as shown on **Figure C-19**. The lower portion of the Whitney Creek Reservoir to Homestake Reservoir pipeline is crosses a deer migration corridor. Large numbers of deer migrate through this area and loss of this habitat or disturbance during migration could interfere with migration or change migration routes. Mitigation strategies could include the scheduling of construction and operational activities so that they do not coincide with migration periods, and restoration of habitat following construction. Impacts to deer migration will be an important issue to be addressed in the permitting process but should not be a significant impediment to permitting.

For elk populations and habitat, all Whitney Creek Reservoir alternatives and a large portion of the associated pipeline routes would be located within elk winter range, severe winter range and winter concentration areas, as shown on **Figure C-20**. Large populations of elk migrate from summer concentration areas and overall range surrounding the project area, to and from the Whitney Creek Reservoir area in the late fall, winter, and spring. An important elk production (calving) area is located approximately one mile to the west the Whitney Creek Reservoir site. This area is considered critical habitat for elk, and all the reservoir alternatives and pipelines could adversely affect the elk population.

The Whitney Creek Reservoir alternatives would permanently reduce the amount of critical winter range for elk and the pipelines would reduce the amount of available habitat during construction and for a period of several years after construction pending reestablishment of habitat and forage vegetation.